Compressed Air Magazine

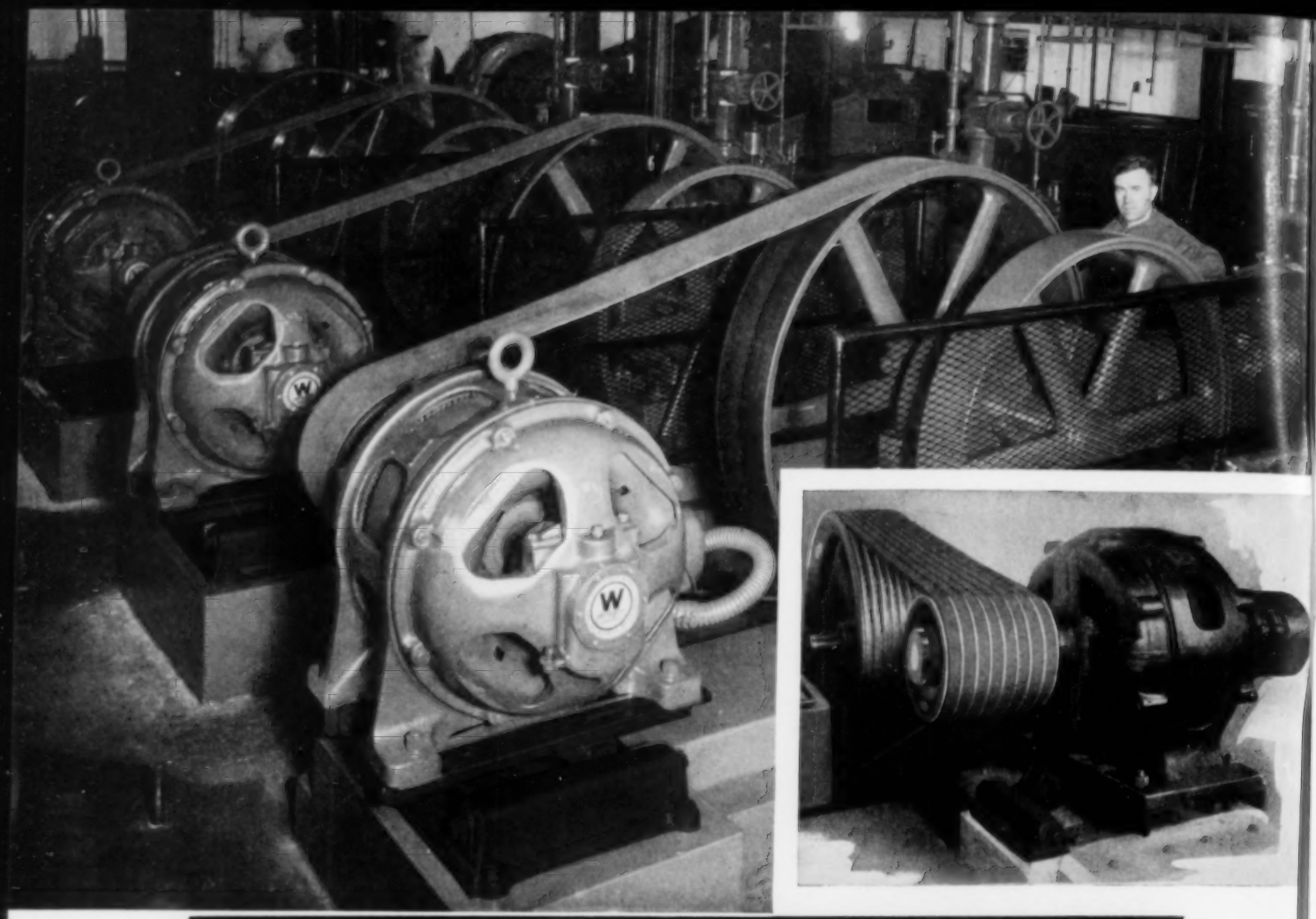
AUGUST 1944

MARINE TRIBUTE TO THE SEABEES

Sign erected by Devil-dogs on road built by Construction Battalion.

VOLUME 49 • NUMBER 8

NEW YORK • LONDON



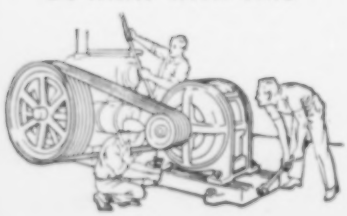
ROCKWOOD *automatic belt tightening* MOTOR BASES

WHEN EQUIPPED WITH A ROCKWOOD MOTOR BASE THE BELTED COMPRESSOR IS STILL YOUR BEST COMPRESSOR

Compressor manufacturers and users both agree that the good old belted compressor is still the most compressor for the least money.

But not all compressor manufacturers and users realize that, by keeping the belt tightness adjusted automatically to match the load with a Rockwood belt tightening motor base **compressor capacities are increased**—so the ever dependable performance of the belted compressor is made even more reliable and it becomes an even more economical purchase.

DO AWAY WITH THIS



Gone forever is the trouble and annoyance of manual belt take-up when Rockwood automatic belt tightening motor bases are used. The belt is then kept automatically tight and just the right tightness to match the ever changing load.

With flat belts or multiple V-belts the Rockwood pivoted motor base assures maximum compressor performance — WITHOUT INTERRUPTIONS —WITHOUT BELT TROUBLE. No longer will the belt slip and the compressor slow down at peak loads. Gone are the worries about belt wear and breakage. With Rockwood motor base the belts will have nearly double their former life. Drive maintenance will be nearly all eliminated. The Rockwood motor base becomes your drive maintenance man.

YOU DO NOT HAVE TO WAIT UNTIL YOU BUY A NEW COMPRESSOR TO INSTALL A ROCKWOOD DRIVE. You can install one under ANY compressor belt drive motor you now have—use the same belts—Rockwood bases are available—up to 60 h.p. from stock—up to 250 h.p. (semi stock) delivered with reasonable promptness—still larger sizes prices and delivery quoted on request.

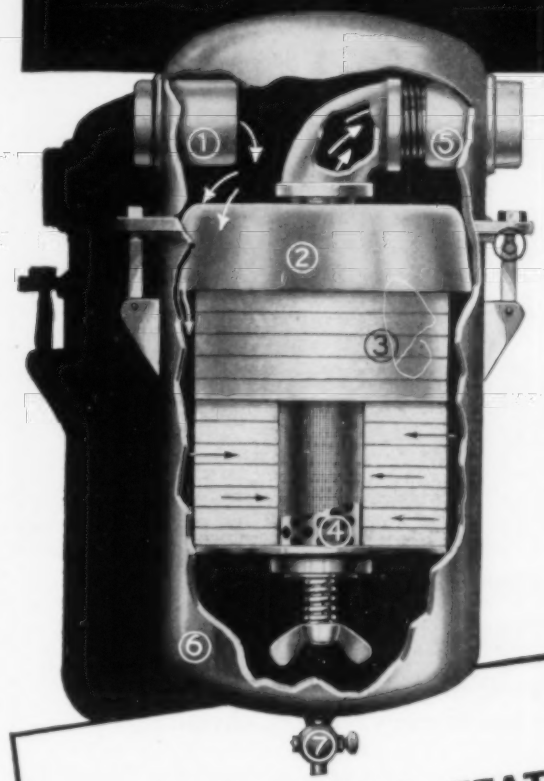
ROCKWOOD MANUFACTURING COMPANY

INDIANAPOLIS, INDIANA - DISTRIBUTORS

WITH STOCKS IN EVERY LARGE CITY

Compressor motors mounted on Rockwood Bases produce more air and at lower overall costs

HAZARD of Oil and Moisture in Automatic Controls NOW ELIMINATED



New Filter Delivers Dry Air Only

Amazing results are being reported by users of the Model AAPHS Pipe Line Filter as a final stage in the protection of delicate pneumatic control instruments.

Typical comment is that of a large producer of electric and steam power who says, "We tried several well-known methods of moisture and oil elimination without satisfactory results. Your Model AAPHS was finally installed in the air line and since then we have had no trouble whatever with oil or moisture in our automatic controls."

NEW 44-PAGE CATALOG: Describes entire line, including filters for building ventilation, pipe lines, engine, and compressor intakes. Your copy is ready.

DOLLINGER CORPORATION
(Formerly Staynew Filter Corp.)
7 CENTRE PARK, ROCHESTER 4, N. Y.

"Air Filter Headquarters"

STAYNEW PROTECTOMOTOR FILTERS

CONSTRUCTION FEATURES

(1) inlet; (2) baffle that distributes vapor-laden air to sides of container (6); (3) felt rings; (4) perforated liner; (5) outlet; (7) drain cock; (8) swing bolts for easy inspection (optional).

THICK FELT RINGS that remove every trace of oil or moisture.

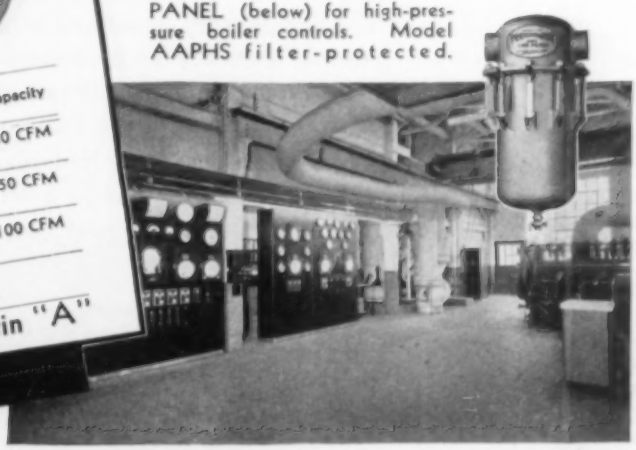
SPECIFICATIONS

Model	Standard Pipe Size	Capacity
AAPH-02 AAPHS-02	¼"	5 CFM
AAPH-01 AAPHS-01	¼"	7 CFM
AAPH-0 AAPHS-0	½"	10 CFM
AAPH-1 AA-PHS-1	¾"	20 CFM
AAPH-2 AAPHS-2	1"	30 CFM
AAPH-4 AAPHS-4	1½"	50 CFM
AAPH-5 AAPHS-5	2"	100 CFM

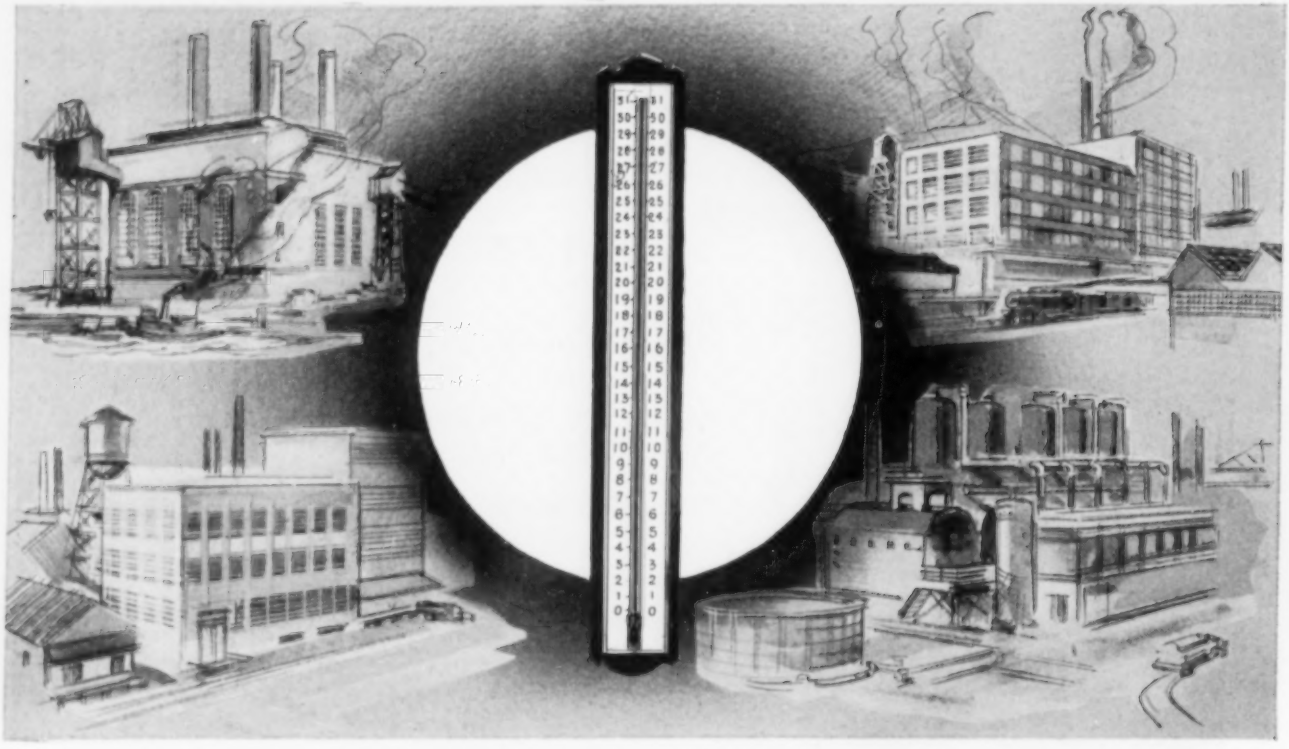
Letter S in code numbers indicates swing-bolt type which facilitates inspection.

Write for Bulletin "A"

PANEL (below) for high-pressure boiler controls. Model AAPHS filter-protected.



Harnessing A VACUUM.



VACUUMS, or low absolute pressures, play a vital role in the operation of steam-driven prime movers and in many refinery, chemical, drug, food and industrial processes.

Properly harnessed and controlled, vacuums aid in performing many services, such as: lowering boiling points; increasing prime-mover efficiencies; dehydrating and hydrating; refining of petroleum and other products; impregnating dyes, preservatives and other fluids; cooling and refrigerating, etc.

Ingersoll-Rand is one of the few manufacturers that builds a complete line of vacuum-producing equipment including: steam-jet ejectors, surface condensers, barometric condensers, and reciprocating dry-vacuum pumps, together with vacuum-refrigeration units. There is also a complete line of centrifugal pumps for circulating water and other liquids in connection with the vacuum equipment.

Our engineers have had years of experience in applying this vacuum-producing equipment to a wide range of work. They will be glad to consult with you on your vacuum processes.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

4-488

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

FIGHTING *Fire* WITH *Ice*

LATEST wrinkle in fighting oil fires is dry ice "slush" . . . which is the familiar dry ice "snow" mixed with water to form a smothering blanket. Huge tank trucks used by Army firemen carry 500 gallons of water and 3 tons of CO_2 maintained at 300 lbs. pressure by an integral compressor.

Whether compressing gases for fire fighting, or compressing air to operate the air-driven tools of industry, proper lubrication is essential to efficient compressor performance. That is why it pays to use Texaco.

Texaco Alcaid, Algol or *Ursa Oils* assure wide-opening, tight-closing valves, free piston rings, open ports, clear lines. Their use in air compressors is nationwide. They assure maximum service life between overhauls, fewer repairs and replacements.

Texaco lubricants have proved so effective in service that they are definitely preferred in many fields, a few of which are listed at the right.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States.

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ *More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.*

★ *More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.*

★ *More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

★ *More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.*

★ *More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.*

TEXACO

TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT – CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

RockerShovel Rec

Three contractors drove 13 miles of tunnel under the Continental Divide — all used the Eimco RockerShovel for loading muck and rock. S. S. Magoffin Company recently completed 8 miles of this stupendous undertaking and the following testimonal bears witness to the remarkable record made by Eimco's Model 21 Rocker-Shovels.

FRANK R. PURVIS
General Superintendent
S. S. Magoffin Co.

S. S. MAGOFFIN COMPANY
GENERAL CONTRACTORS

ENGLEWOOD, COLORADO

Estes Park, Colorado.
June 18, 1944

The Eimco Corporation,
634-666 South Fourth West Street,
Salt Lake City 8., Utah.

Attention Mr. D. W. Saunders.

Dear Mr Saunders:

Referring to your letter of April 27th herewith data requested by you.

Total advance	42994 Lineal feet.
Best daily advance	74 Lineal feet.
Best monthly advance	1554 Lineal feet.
Average advance per work day	40.7 Lineal feet.
Average advance per shift	14.4 Lineal feet.
Average depth of round	6.2 Lineal feet.

We have several times loaded fourteen cars of 92 cubic feet capacity in fifty minutes, but average would run approximately one hour and twenty minutes, due to hand work necessary in supported sections.

For a tunnel up to this size, your machine is hard to beat. It would not suit a larger tunnel. As you know we have four of the 21 machines and one of the old 20 machines, probably the first one you put out. We kept three close to Heading at all times, so delays due to break downs were negligble. Considering the constant beating these machines were taking all the time, with the heavy muck cars rolling against them at high speed while switching, they stood up marvelously well. All our machines after driving 43000 feet of tunnel are still in good operating condition.

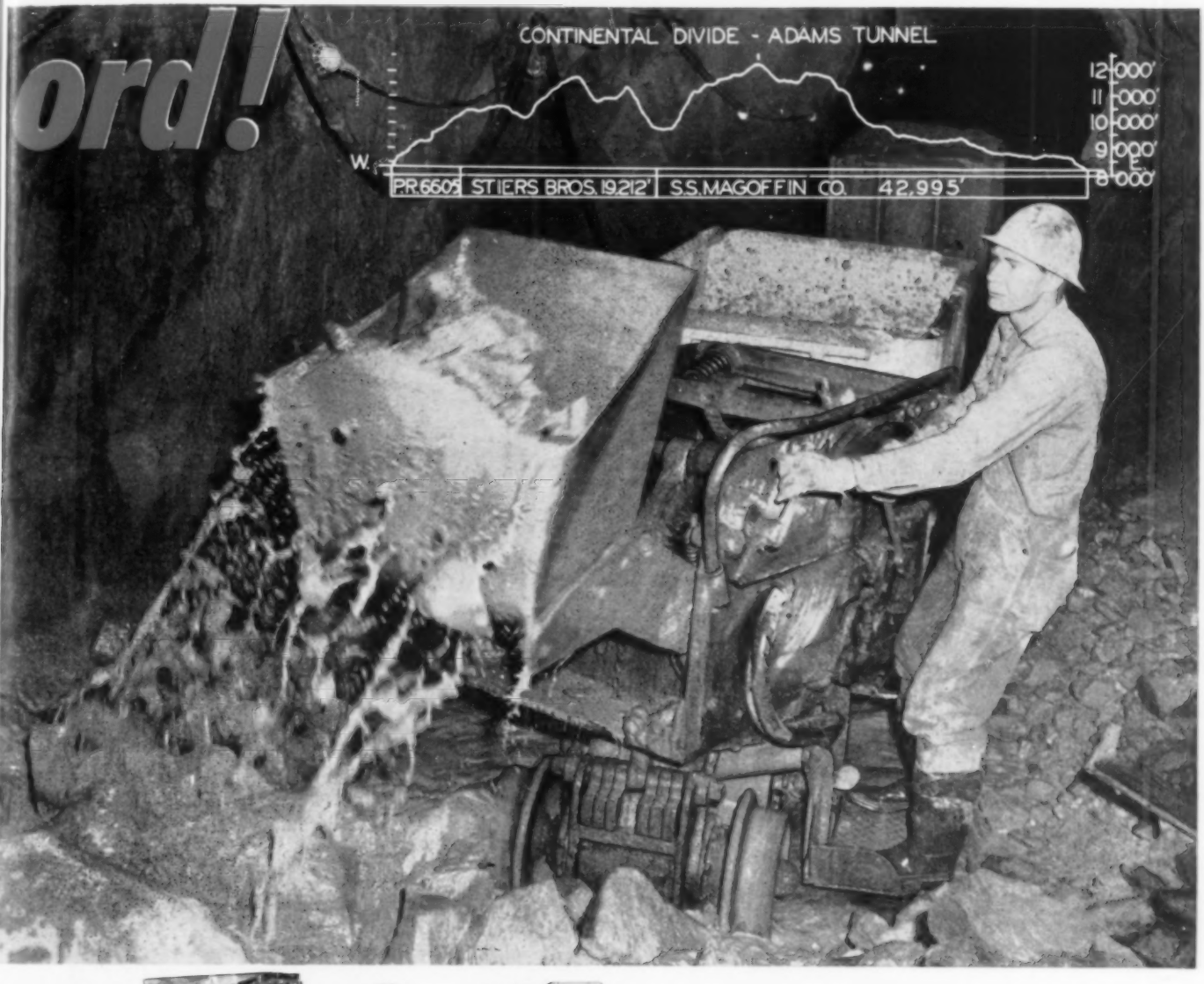
Rest assured we give your machines due credit for the part they played in holing through the Continental Divide Tunnel. Their performance has been 100% throughout and for a tunnel up to this size your machine for steady dependable day after day operation in getting that muck pile cleared is "TOPS".

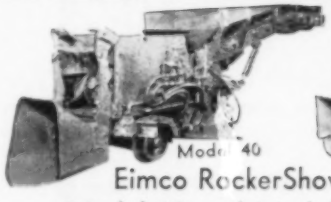
Yours very truly,

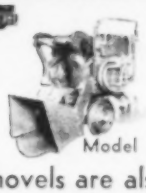
S. S. Magoffin Company

By H. R. Purvis
General Superintendent

A 64




Model 40


Model 12B

Model 21

Eimco RockerShovels are also available in the Model 40 and Model 12-B sizes and are earning similar testimonials in their respective fields. For tunnels larger than the Continental Divide Tunnel or underground headings, the Model 40 Rocker-Shovel is daily establishing records. For smaller tunnels and drifts, crosscuts or haulageways in mines, the Model 12-B is standard equipment the world over.

Eimco RockerShovels are designed to fit the job and provide maximum efficiency, record tonnages and lowest operating costs. - - - Yes, some RockerShovels have been in continuous service for more than 10 years and are "still in good operating condition."

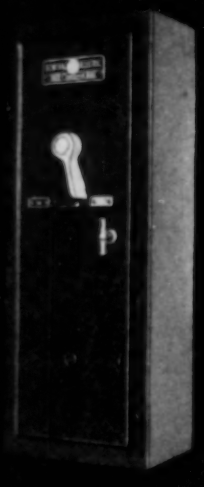
Eimco RockerShovel

EIMCO

THE EIMCO CORPORATION, Salt Lake City 8, Utah
New York 5: 67 Wall Street Sacramento 14: 1217 - 7th Street
Chicago 2: 111 W. Washington St. El Paso, Mills Building

ONE COMPACT UNIT

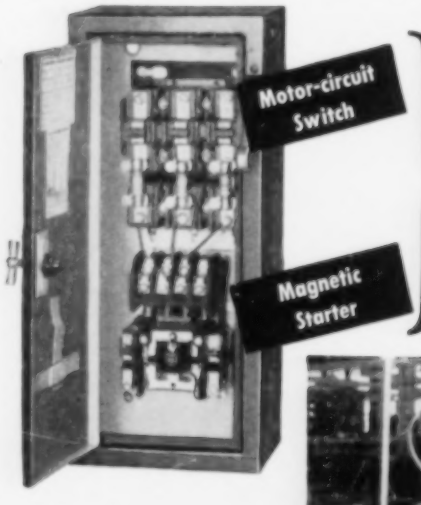
FOR MOTOR CONTROL AND PROTECTION



You can save time and space ...gain greater protection, too

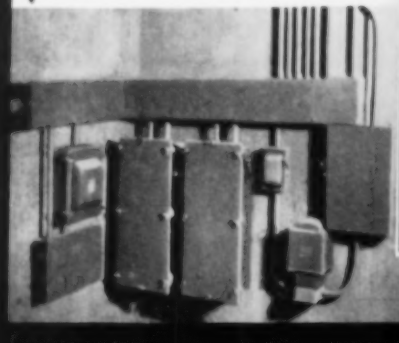
WHY TWO DEVICES?

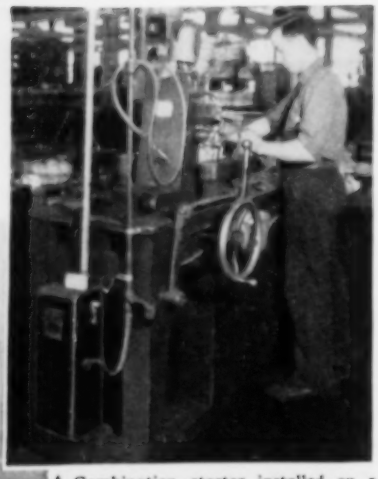
ONE CAN DO THE JOB



COMBINATION STARTER

These starters in dust-tight enclosures provide reliable operation.





Combination starter installed on a special machine for assembling ribbon cores to transformer coils.

YOU no longer need buy a separate device for each function of motor control. Now you can get *combination* control—in a *variety of enclosures* to meet every operating condition. This control combines a motor-circuit switch and a magnetic starter in one, compact, easy-to-mount unit.

1. **Reduced Installation Time**—Users of these starters report a 50 per-cent reduction in mounting time and a 40 per-cent reduction in wiring time.
2. **Motor Protection**—With G-E combination starters, you're sure that the rating of the motor-circuit switch matches that of the magnetic starter with which it is to be used.
3. **Greater Safety**—The motor-circuit switch, or breaker, being in the same case with the magnetic starter, is mechanically interlocked with the cover. Thus, the cover cannot be opened while there is power on the starter.
4. **Less Space Required**—Combination starters take up less mounting space than separately mounted safety switches and starters.
5. **Quick Selection**—By ordering *one* factory co-ordinated unit instead of two, you can save time. You specify the motor rating, the type of motor-circuit switch you want, and the application you have in mind—we'll send the starter you need.

Need More Information? These starters are also available for high-voltage motors. For further information on G-E combination starters write to our local office for Bulletin GEA-3715. *General Electric Co., Schenectady 5, N. Y.*

BUY WAR BONDS

GENERAL ELECTRIC

676-131C-8920

HOW TO SOLVE

Operating Problems with *Correct Lubrication*

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

Use "BLACK MAGIC" on Your Gears!

THOSE big, open gears need strong, continuous protection against damaging wear.

Here's the answer—the "Black Magic" of Gargoyle Viscolite Fluids.

These practical Socony-Vacuum lubricants contain a volatile, non-inflammable diluent that makes them flow freely. Thus, they can be applied with drip oilers, mechanical lubricators, oil cans, or spray, or painted on with a brush.

But once distributed on the gears, the diluent in the fluid evaporates and leaves tough, tacky films that stick on like glue—take the jolts out of shock loads—provide maximum protection for the gear teeth with minimum feeds.

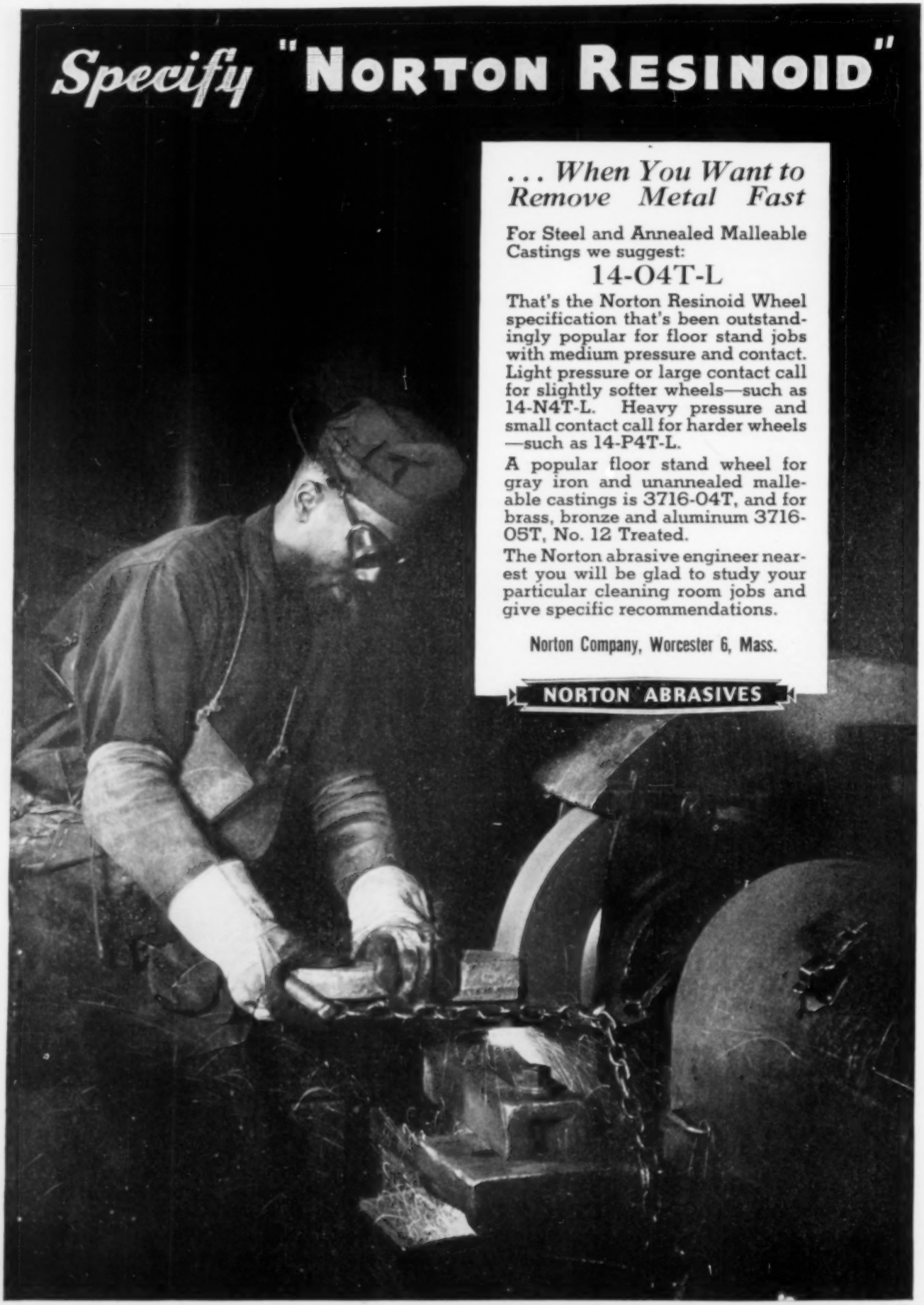
Put this efficient, economical protection on your gears now!

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC.—Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Magnolia Petroleum Co. • General Petroleum Corp. of California

CALL IN SOCONY-VACUUM

Specify "NORTON RESINOID"



. . . When You Want to Remove Metal Fast

For Steel and Annealed Malleable Castings we suggest:

14-O4T-L

That's the Norton Resinoid Wheel specification that's been outstandingly popular for floor stand jobs with medium pressure and contact. Light pressure or large contact call for slightly softer wheels—such as 14-N4T-L. Heavy pressure and small contact call for harder wheels—such as 14-P4T-L.

A popular floor stand wheel for gray iron and unannealed malleable castings is 3716-04T, and for brass, bronze and aluminum 3716-05T, No. 12 Treated.

The Norton abrasive engineer nearest you will be glad to study your particular cleaning room jobs and give specific recommendations.

Norton Company, Worcester 6, Mass.

NORTON ABRASIVES

W-970

ON THE COVER

IN HONOR of the Marines who took the ground from the Japs, the Seabees named one of the roads they built on Bougainville Island *Marine Drive Highway*. The Marines returned the compliment by putting up the sign shown on our cover picture. A Marine and a Seabee are shown shaking hands in front of it. The picture is an official U.S. Marine Corps photograph taken by Capt. Patrick O'Sheel.

•

IN THIS ISSUE

THE following parody on *The Marines' Hymn* was found in *The Butler Miner:*

From the halls of Montezuma to the shores of Tripoli
It used to be the Leathernecks, but now it's all Seabee;
And when we reach the pearly gates and stand in Heaven's scene,
There'll be a Seabee waiting there to greet the first Marine.

Being an ex-wearer of the Marines' "ball and hook" in World War I, we naturally don't believe a word of it, but the verse pays a nice tribute to the Seabees, as does our leading article.

•

AS DESCRIBED in our second article, the hydropneumatic accumulator system that is generally used to maintain the desired water pressure in descaling steel sheet and strip has been applied to the making of shell forgings by the J. B. Beaird Company of Shreveport, La.

•

NOT being able to travel much these days, most of us have to do our sight-seeing vicariously. In this issue we are privileged to view Carlsbad Caverns through the eyes of Carey Holbrook, a capable observer.

•

THE mechanization of mines increases production, reduces costs, and lessens worker fatigue. The use of hoists and scrapers for moving ore and rock is being continually extended. A short article tells how the slushing system is advantageously employed by one of the British Columbia's leading base-metal producers.

•

AIRFIELDS from which our super-bombers can effectively assault Japan are being established in various parts of China, largely with Chinese labor and age-old construction methods. A 2-page spread of pictures shows different phases of the operations at one of the sites.

Compressed Air Magazine

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EDITORIAL CONTENTS

Our Seabees—*R. G. Skerrett* 192
Pneumatic Accumulator Aids Shell Forging—*C. H. Vivian* 198
Carlsbad Caverns—*Carey Holbrook* 204
Ancient Methods Build Modern Airfields 208
Slushing at Britannia Mines—*T. M. Waterland* 210
Air-Operated "Razors" for Rivet Heads 212
This and That 213
Editorials—The Trend of Power—Tunnels Aid Mining 214
Lawrence B. Abrams 215
Mobile Bins Solve Storage Problem 215
Belts Spliced in Place 215
Industrial Notes 216

ADVERTISING INDEX

Air-Maze Corp. 41
Allis-Chalmers 23-24
American Air Filter Co., Inc. 45
American Brass Co., The 21
American Hoist & Derrick Co. 35
American Optical Co. 19
Atlas Steel Casting Co. 39
Bird-White Co. 35
Bethlehem Steel Co. 17
Bucyrus-Erie Co. 44
Burgess-Manning Co. 39
Burgess-Norton Mfg. Co. 37
Carborundum Co., The 13
Conrader Co., R. 11
Cook Mfg. Co., C. Lee 27
Crane Co. 18
Dayton Rubber Mfg. Co., The 38
Dollinger Corp. 3
Easton Car & Construction Co. 16
Eimco Corporation, The 6, 7
Garlock Packing Co., The 33
General Electric Co. 8
Goodrich Co., B. F. 14
Hercules Powder Co., Inc. 32
INCO Engineering Co. 33
Industrial Clutch Co., C. M. Eason 29
Ingersoll-Rand Company 4, 30, 36, 3rd Cover
Johnson Corp., The 35
Maxim Silencer Co., The 28
Murphy & Co., Jas A. 39
New Jersey Meter Co. 43
Niagara Blower Co. 12
Nicholson & Co., W. H. 37
Norgren Co., C. A. 35
Norton Company 10
Powell Co., The Wm. 31
Rockwood Manufacturing Co. 2nd Cover
Shell Oil Co. 20
SKF Industries, Inc. 15
Socony-Vacuum Oil Co., Inc. 9
Square D Co. 39
Texas Company, The 5
Timken Roller Bearing Co., The 4th Cover
United States Steel Corp. 26
Victaulic Co. of America 34
Vogt Machine Co., Henry 22
Wagner Electric Corp 37
Walworth Co. 25
Waukesha Motor Co. 40
Westinghouse Air Brake Co. 43
Westinghouse Elec. & Mfg. Co. 42
Wisconsin Motor Corp. 33

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

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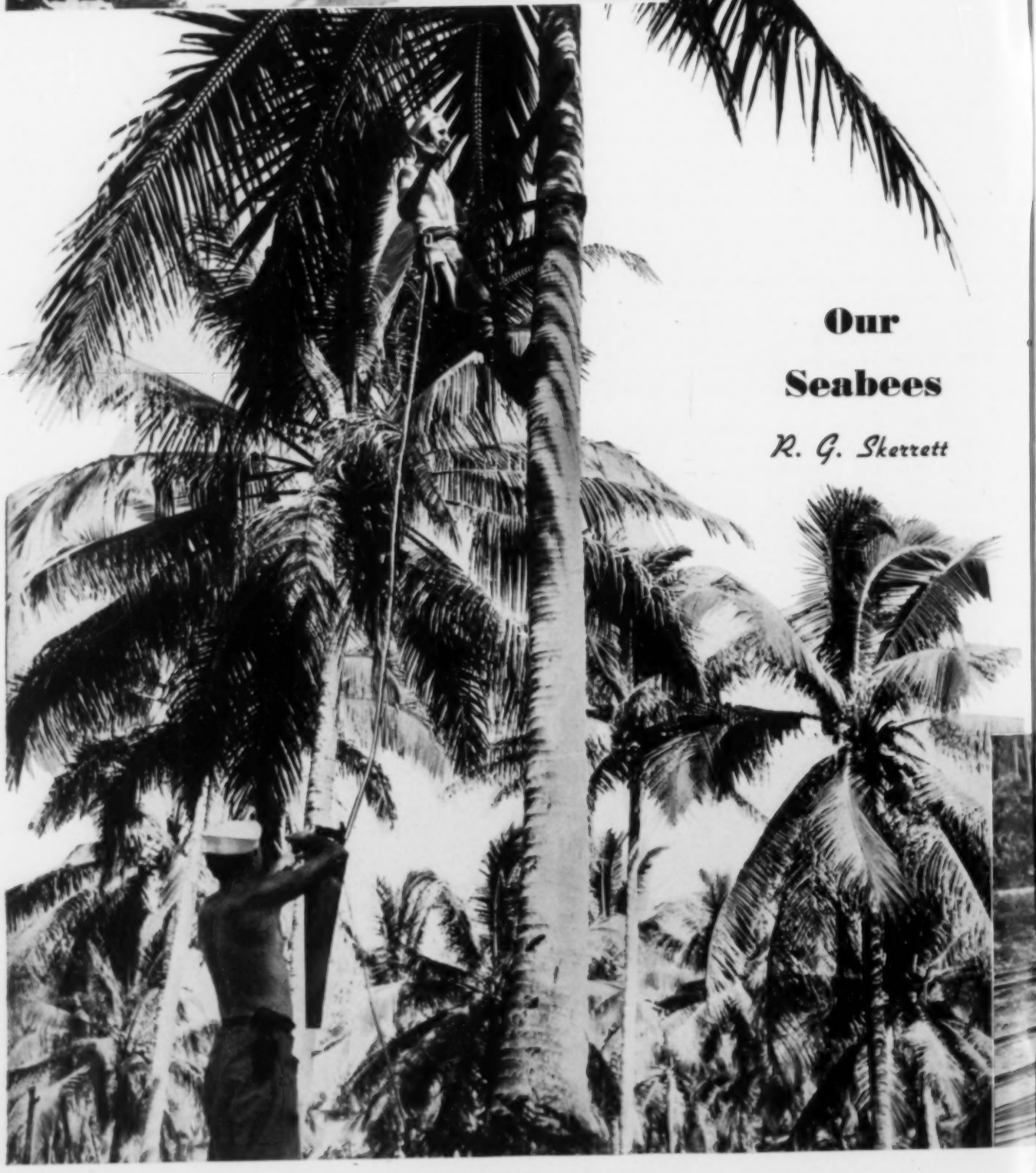
Our Seabees

R. G. Skerrett



SEABEES we call them, and for the best of reasons. The Japs have probably nicknamed them Hornets, for certainly the Nips have been stung by them on numerous occasions.

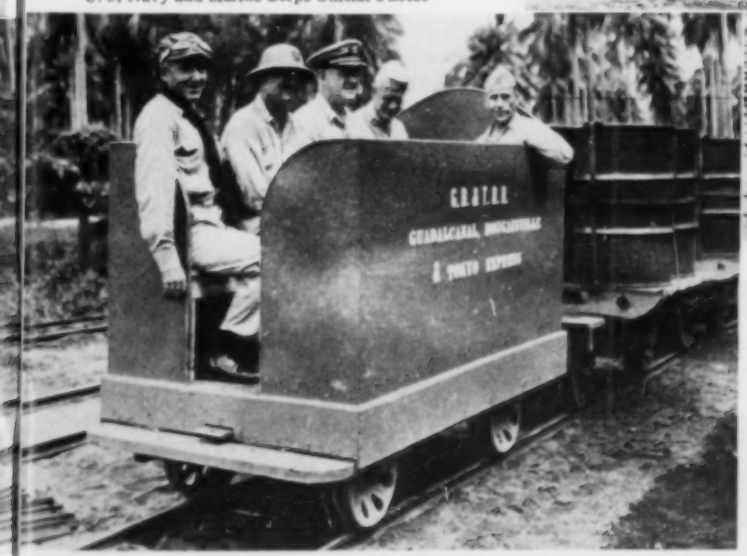
The Seabees have won an enviable reputation; and even the hard-hitting Marines treat them as buddies and worth-while fellow fighters on the firing line. In the beginning they were something of an experiment in the combatant force of our naval personnel and were instituted to help make our battle fleet the better able to engage in modern amphibious warfare. Although organized to do construction work at advance bases, their activities were found to be equally necessary at so-called "mobile bases." That is, as we move forward to flank the Japanese or to drive them from their established footholds they are needed to transform the latter into bases that will serve our purposes. In all these operations the Seabees have shown that they can both build and fight with thoroughness and promptness despite enemy opposition and difficulties offered by Nature.

The Seabees were originally tagged with the imposing designation of Construction Battalions and for brevity were referred to as C.B's, from which the humorous members of the force quickly evolved "Seabees." That substitute rating was approved by the Navy Department, and so was the pugnacious device designed to distinguish them as both a fighting and working component of the naval service. Some day, that badge will have the regarded merit of a coat of arms.

The Bureau of Yards and Docks is normally responsible for the rearing and maintaining of all the permanent facilities established at naval shore stations—yards and bases of various kinds; and the vast amount of work involved in this province of the Civil Engineer Corps of the Navy is more than enough to occupy the attention of this staff corps, which is not expected to perform combatant service. But circumstances have changed all this, and to meet the present emergency it has been greatly augmented by competent reserve officers with civil-engineering training. The Seabees are being led in their amphibious operations, and even in actual battle, by officers of this corps who also have been given special training to meet the manifold needs of present-day warfare.

Shortly before the Japanese raided Pearl Harbor, the Navy was engaged somewhat feverishly in the Pacific and elsewhere in strengthening and fortifying some of our insular outposts that were counted upon to help guard us from attack upon our continental seaboards. The work then underway was being done by private companies which had in their employ large forces of civilians well qualified and fitted for the jobs in hand. At Pearl Harbor, and a few hours later at Wake Island, those civilians were suddenly exposed to the hazards of warfare. Under the Geneva Convention, to which all international powers have subscribed, those men could not take up arms, even if they knew how to use them, for their own defense. Construction operations had to be carried on at our offshore bases after war was declared on Japan, and the logical solution of the difficulty lay in forming in the Navy a force familiar with the requirements of the service and yet functioning primarily as the builders of advance bases for the

U. S. Navy and Marine Corps Official Photos



AROUND THE WORLD WITH THE SEABEES

On a South Sea island (above), members of the Seabees are spreading coral on wire mesh in constructing a road. In three days Seabees built a 1.22-mile railroad on Guadalcanal and completed its terminus in two more days. At the left, a group of Army, Navy, Marine, and Seabees officers are seen christening the line by a ride in its only "Pullman" car. As troops advance, Seabees are right on their heels stringing power lines with palm trees for poles (opposite page). Not all Seabees work in warm climes. The communications crew at the top-left is training for duty in the Far North. Highly expressive of the Seabees is the creature that serves as their insigne (circle).

Official U. S. Navy Photos

fighting fleet, for its landing forces, and for the needs of all the associated organizations. These men, of course, were to be in uniform, suitably trained to fight, and to be commanded by naval officers.

Vice-admiral Ben Moreell, Chief of Civil Engineers and Chief of the Bureau of Yards and Docks, requested the formation of Construction Battalions; and on December 28, 1941, authority was given to begin recruiting them. The initial regiment was to have a total strength of about 3300 and to be composed of three battalions each numbering around 1080 men and 32 officers and made up, in turn, of four construction companies and one headquarters company. Each battalion was to be a self-contained unit.

During the drive for the first regiment, Vice-admiral Moreell made this appeal to the men he hoped to get: "This is a real opportunity for those two-fisted, red-blooded Americans who are not fighting behind a gun to serve shoulder to shoulder with the combatant forces of the Naval service." The response was prompt and enthusiastic. Men of wide experience in 60 different trades came forward to enlist, and when found physically fit were given ratings in the Navy commensurate with their qualifications and callings or trades. Since the raid on Pearl Harbor, the ranks of the Seabees have drawn to them a truly splendid body of workers and fighters, which explains their adaptability and the extraordinary manner in which they have met and mastered conditions confronting them in many different climates.

In less than six months from the initial drive for enlistment the Seabees were recruited to six regiments—about 20,000 men. Today there are around 240,000 in the organization, forming 230 battalions of which the majority are engaged in construction work, while a relatively small number is doing base-maintenance, demolition, and other important work. These special battalions are interesting and exemplify some of the manifold ways in which the Seabees have proved their worth to the battle fleet.

For instance, our enemies have consistently done every tricky thing to make their defenses dangerous to our men, even after retreating, and Seabee combat demolition units go with the first wave of landing troops to destroy obstacles that might block beachhead operations. This work is hazardous. Other special services they may be called upon to perform are the making of emergency repairs on landing craft or transports and helping to unload large guns, ammunition, and other fighting equipment while under enemy fire. There is a division that centers its efforts upon the loading and unloading of supply vessels. This is one of the vital operations in keeping the battle fleets fully prepared to carry on at all times even though thousands of miles away from home or advance bases from which food, ammunition, fuel, and other expendable materials must be distributed. The majority of these men have been recruited from American stevedores who know how to handle, stow, and unload cargoes. A sizable group of Seabee officers has been given intensive training in the latest methods of cargo handling, and these men are seeing service wherever we have bases and wherever the Navy is engaged.

Admiral Ernest J. King, Commander-in-Chief of the United States Fleet and Chief of Naval Operations, has recently referred to the Seabees and what they have already done as follows, and as this eminent official judges performance by a standard of high efficiency, what he has said about them is significant.

"The accomplishments of the Seabees have been one of the outstanding features of the war. In the Pacific, where the distances are great and the expeditious construction of bases is frequently of vital importance, the construction accomplished by the Seabees has been of invaluable assistance. Furthermore, the Seabees have participated in practically every amphibious operation undertaken thus far, landing with the first waves of assault troops to bring equipment ashore and to set up temporary bases of operation.

"In the Solomon Islands campaign, the Seabees demonstrated their ability to outbuild the Japs and to repair airfields and to build new bases, regardless of conditions of weather. Other specialized services performed by the Seabees include the handling of pontoon gear, the repair of motor vehicles, loading and unloading of cargo vessels, and, in fact, every kind of construction job that has to be done. At present, the Seabees number slightly more than 240,000, nearly half of whom are serving overseas at various outposts. Fleet commanders have been and are generous in their praise and appreciation of the work done by Construction Battalions everywhere. There can be no doubt that the Seabees constitute an invaluable component of our Navy."

To those of us who are familiar with great construction works calling for the collaboration of competent workmen in

TRAINING-CAMP VIEWS

In the rigging school (top-left) Seabees are taught how to go aloft and rig a high line or a cableway for the transfer of heavy and bulky materials. Although they are primarily constructors, they are schooled in demolition work. In the center they are shown tearing out concrete with an air tool and a sledge. Instruction in the assembly, overhaul, and repair of motive machinery (top-right) is an important part of the training. They also learn how to erect tanks for the storage of water, gasoline, or motor oil (bottom view).

many trades, it is not hard to visualize the diversified composition of the Seabees. At the beginning, the organization drew to it some of our best automotive mechanics, machinists, carpenters, quarry drill runners, concrete workers, divers, powder men and blasting experts, power men, metalworkers, longshoremen, riggers, and operators of various types of mechanical equipment. Cool-headedness, steady nerves, and courage have repeatedly been asked of these men in carrying on their jobs in civil undertakings, and the way they have met perils under fire is just what one would expect of them. All that was needed to fit them into naval life for war work was a comparatively short but intensive period of training under Marine Corps top sergeants and chief petty officers of the Navy at Naval Construction Training Centers located, respectively, near Williamsburg, Va., at Davisville, R.I., and at Quoddy Village, Me. These camps have been handling 60,000 men at a time. Two other stations are located on the Pacific Coast, one for training and the other for rest and recuperation.

Qualified Seabees are ready to fight with any of the weapons used by assault troops; to build jetties, wharves, bridges, trails or roads in jungle wildernesses, ramps for seaplanes, and landing strips and runways for planes; and to aid in the salvage of ships as well as matériel which could not be replaced except from some source thousands of miles away. Improvising has been the crowning achievement of many of their performances. Repeatedly, they have beaten all estimates of time of completion, and again and again have done what was believed to be impossible.

Books could be written about the achievements of the Seabees in their far-flung fields of overseas service. They have worked in the waters of Alaska and in the Aleutians; in the South Atlantic, the Caribbean, and the Galapagos Islands; on the coast of Africa, Sicily, and elsewhere in the Mediterranean; and in the Persian Gulf—not to mention the much that has been accomplished by them in England and Ireland. But, undoubtedly, their most spectacular performances have been among the islands of the Pacific in our campaign to uproot the aggressive Japanese. In all that the Seabees have done they have shown great determination and the spirit and urge of a special cause that goes back to 1941 to work at Wake by a construction force sent there by the Government to build an air base for the Navy and necessary defenses. The story of that undertaking and of the attacks on Wake—beginning a few hours after the raid on Pearl Harbor and continuing with nearly clocklike regularity for fifteen days from air and sea—sowed the seed of retaliation

Official U. S. Marine Corps Photo

MARINES AT TARAWA

Devildogs going over the top in the battle for the airfield on the tropical island. Close behind them were Seabees, who helped to establish the beachhead.

that is producing an abundant crop of retribution through the services of the Seabees.

Wake Atoll is V-shaped and made up of three small islands—Wake, Peale, and Wilkes—that lie in the watery waste of the Pacific 2100 miles west of Honolulu and nearly double that distance from San Francisco. The lower part of the V is Wake, at the eastern end, and the western and open end is barred to ships by an outlying reef of coral. The lagoon within the V, although comparatively shallow, affords an excellent haven for seaplanes of all sizes. The atoll has a land area of about 2600 acres and does not rise more than 23 feet above sea level. It is said that the tiny coral-forming polyps built it upon the crest of a volcanic peak that has its base on the sea bed 2000 fathoms down.

Wake Atoll received little attention from seafarers of the past owing to its modest size, lack of fresh water, and great difficulty in making a landing except at a single 30-foot break on the south side of the enveloping reef. But when a trans-Pacific cable was advocated, it was considered as an intermediate anchorage for that line of communication. The captain of the *U.S.S. Bennington*, Commander Edward D. Taussig, U.S.N., was directed to take possession of the island group in the name of the United States—no other nation having previously done so, so far as was known. That was accomplished on January 17, 1899, and until 1935, when Pan American Airways constructed an airfield there for its San Francisco-Orient service, the atoll remained a sanctuary for sea birds. When the trans-Pacific cable was actually laid, it by-passed Wake. The experience gained in creating that way station, including a sizable hotel on Peale Island, proved what violent gales and pounding seas can do to the works of man bent upon establishing himself at exposed places. This brings us to January 11, 1941, when the *U.S.S. W.W. Burrows*—formerly the motorship *Santa Rita* of the Grace Line, landed the pioneer force that was to build the naval air base.

All the holds of the *Burrows* were stowed with power-driven rollers, scrapers, tractors, trucks, cement mixers, boilers, electric lighting and power plants, distillers, air compressors, refrigerators, and what not. In addition there were great quantities of lumber, steel, cement, lubricating oil, gasoline, and dynamite. Her 'tween-deck freight included an array of air-driven tools, an abundance of foodstuffs, tobacco, hard candies, and chewing gum. But what made the *Burrows* look like a brooding hen was her loaded open deck on which were crowded lighters and other craft; and overboard was a small Diesel tug and a large wooden barge 100 feet long and 40 feet wide. This miscellaneous flotilla was to be used in shifting the ship's cargo to the shore and to aid in the work on the beach and within the lagoon after the natural but narrow passageway in the reef had been widened and threaded.

The Bureau of Yards and Docks was represented by Harold Butzine, U.S.N. R., then a lieutenant in the Civil Engineer Corps of the Navy who had previously visited the atoll for surveying purposes; and the contractor's force was under the leadership of Dan Teters, as general superintendent. Teters' gang was composed of seasoned men who had helped to rear some of the largest dams in the United States—most of them in remote or isolated parts of the country.

After the *Burrows* hove to, an advance working force was sent through the break to effect a landing on Wilkes Island, a few hundred yards inshore from the reef over which the surf broke ceaselessly with a thundering roar. Landward of the reef the waters of the cove also contained boulders and coral heads which had to be cleared away before the big wooden barge could be moved and beached to discharge her deck load of power-driven scrapers, hoists, an 80-ton caterpillar crane, and other construction equipment. But the task could not be started until a lighter, 40 feet long and 12 feet wide, was put overboard from the *Burrows* while she rolled in the heavy seaway. Into the lighter were lowered an air compressor, Jackhamers, dynamite, detonating caps, chain cable, wire mooring lines, a sizable anchor, and other paraphernalia.

With everything on board, the tug towed the craft through the "needle's eye" in the reef and then held her just clear of the breakers until she was moored. From that point, skiffs carried the Jackhamers, air hose, and explosives through the surf to the beach. The advance party, which numbered about 50, then began to drill popholes in the underwater boulders and coral heads preparatory to blasting. In some cases the rocks were shattered by bulldozing shots—by planting sticks of dynamite on top of them and holding them in place by sandbags until fired electrically. The workers had to struggle at their jobs on slippery footings and in water often shoulder high, and time and again were bowled over by the waves. Blasting and drilling clouded the waters of the cove, and soundings were made with a man-formed line reaching out from the shore and depending upon contact to discover obstructions.

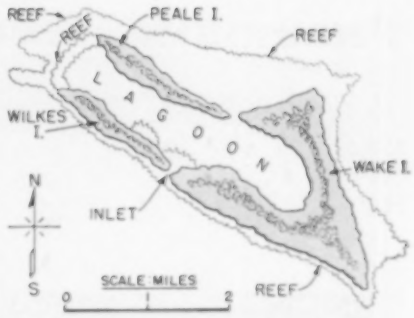
Toiling night and day for about 40 hours, the area was believed to be cleared, and the barge was towed through the widened gap in the reef and anchored a little distance out from the beach. The aim was to take advantage of the next high tide—a rise of less than 2 feet. There she was held by the tug while steel cables were run from her sides to mooring buoys, attached to 3-ton anchors, and from her bow to "deadmen" planted in the sand. The four lines were passed around the drums of Diesel hoists on the deck of the barge, the two leading to the shore

serving with the aid of the hoists to pull the vessel partway up on the beach.

On the afternoon of January 12 the barge was started landward, and all went well until boulders, that had escaped detection, held up the craft 50 feet from the shore line. Then began the kind of action that is expected of quick-thinking and quick-acting construction men. Promptly some of her deck load was moved rearward to change her trim and to lift her bow free of the obstructions. With her nose in the air, the hoists tugged again and succeeded in pulling the barge 40 feet nearer the beach. The crane operator took his cue without hesitation—picked up a ramp from the deck and with it bridged the 10-foot gap. Although the ramp inclined sharply, the drivers of two bulldozers started their motors, and one after the other the chugging machines lurched down on to the island. There, without halting, they pushed the ramp out of the way and began shoving the sand into place to form an easily sloping causeway over which the crane could move from the barge to the shore after it had spotted closely spaced timber crossties on the embankment. By that time night had fallen, and in the glow of the moon the crane, like a tipsy giant, made the short journey without mishap.

These are only a few of the resourceful maneuvers that are commonplaces with such men. They had mastered the first difficulties; and in unloading subsequent cargoes brought by the *Burrows* they followed the same well-ordered procedure. At the height of activities, the contractor's force at Wake totaled 1200 men, Pan American Airways had a limited personnel at the station, the Marine Corps had about 400 ground troops, around 80 officers and men were present in the air force, and there were a few Army men for military communication work. Such was the situation when the Japanese struck on December 8, 1941, Wake time.

The commanding officer of the Marines was notified of the raid on Pearl Harbor soon after it occurred and had his instructions for such a contingency. All that could be done was to make certain preparations and then to wait and wonder from what point the enemy would strike. Only a few days before, a group of twelve naval fighter planes had alighted on the recently built runway, and some of those machines went aloft to look for the foe, who managed to avoid them until Wake was actually bombed. Two squadrons of bombers made the attack, which lasted less than twenty minutes and was concentrated upon grounded aircraft, the airfield, and, to a lesser extent, upon the Pan American Airways station, showing that the Japanese had accurate knowledge of the layout.



MAP OF WAKE ATOLL

The three islands are surrounded by an outlying reef that prevents approach except through a narrow inlet on the south side of the coral formation.

Widespread and heavy damage was done, but loss of life and injuries were limited to the naval force. A Pan American clipper, which had landed shortly before, had been pierced in many places by bullets but was able to evacuate the company's entire personnel the same day. The enemy did not strike the civilian camp until the next day, killing more than 50 of the workers and wounding many others. That savage act, and the deliberate firing on a plainly marked naval hospital—both in violation of the tenets of the Geneva Convention—so enraged the construction men that nearly 200 of them promptly applied for enlistment in the Marines. But because of legal restrictions and our obligations as a party to the Geneva Convention they had to be refused a chance to fight. So they did the next best thing—they worked unsparingly to repair the ravages of the foe's repeated raids upon the atoll.

Those men, like their military comrades the Marines, carried on without cease, paying the price of what each day laid upon them. Perhaps some time we shall know the extent of this toll before they were finally overwhelmed by vastly superior forces in the air, aboard fighting ships, and from crowded transports filled with Japanese troops. Thus we see how the bond between the construction workers and the Marines was first formed under fire; and the Seabees, who now follow them as naval units, have a twofold inspiration to more than measure up to every task confronting them. To every job in every situation the pugnacious Seabees answer: "Can Do."

U. S. Coast Guard Photo

INVADING CAPE GLOUCESTER

An LST (Landing Ship, Tanks), crammed with equipment and supplies and manned by Coast Guardsmen, nearing the Jap-held island of New Britain. The Seabees who loaded this vessel were obviously trained stevedores.

Pneumatic Accumulator Aids Shell Forging

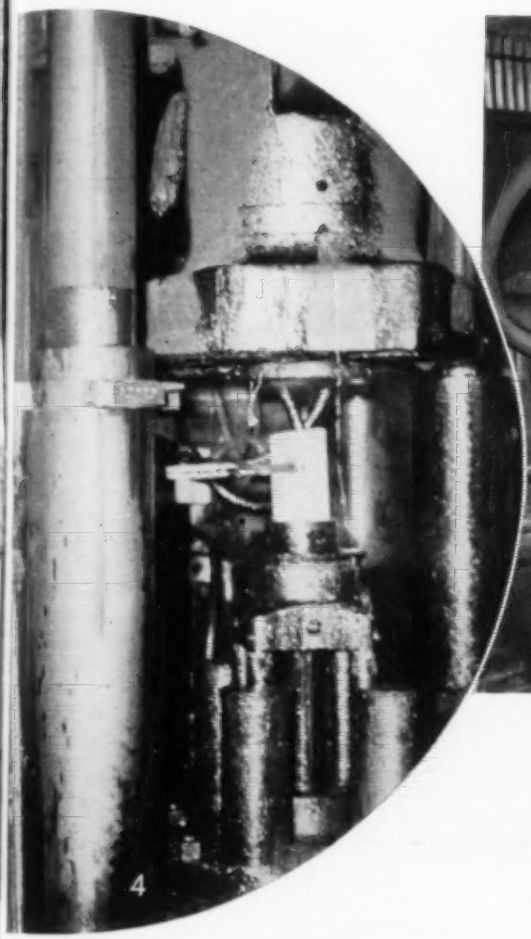
C. H. Vivian

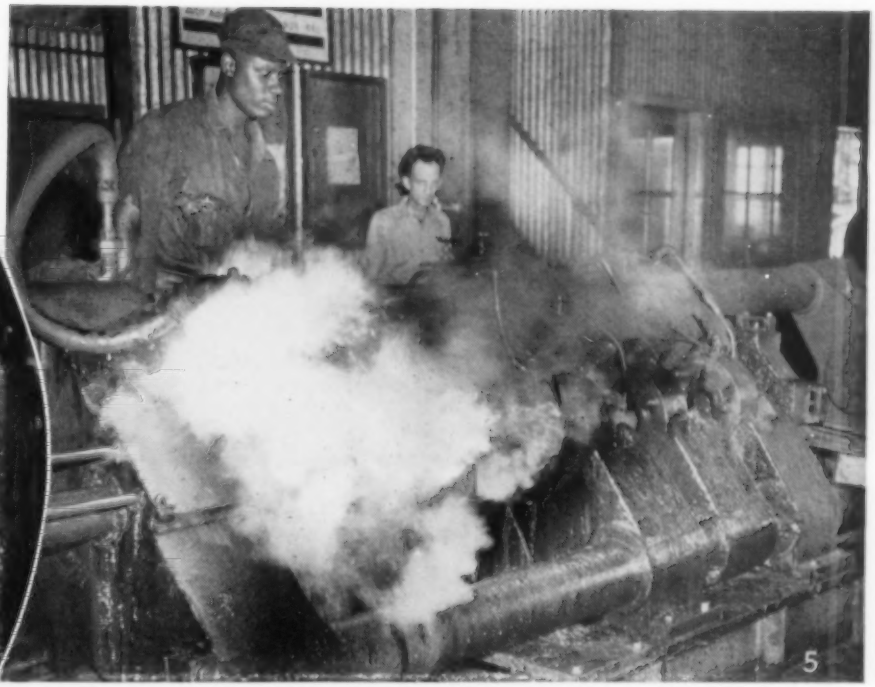
CONSIDERING that modern military operations depend to a great extent upon the use of large-caliber guns, it is a strange fact that history doesn't tell us just who was responsible for these weapons. There is agreement that cannon were introduced soon after the discovery of gunpowder, but the identity of the inventor of that first-known explosive is shrouded in uncertainty. Some authorities credit Friar Roger Bacon of England (1214-1292) with concocting gunpowder by accident while experimenting with saltpeter. Others attribute both gunpowder and cannon to Berthold Schwartz, a German monk; but there are differences in dates that are hard to explain. It is known for certain that gunpowder and cannon were in use in Italy, France, and England by 1344, which was ten years prior to Schwartz's supposed invention of the explosive.

The first cannon fired bolts, darts, stone shot, and langrage, which consisted of bits of iron, nails, flints, etc., encased in a sack or other container. The darts were made of iron feathered with brass and were wrapped in leather, reportedly to offset windage. The charge of gunpowder that served as the propellant was ignited with a red-hot bar or spike. Round metal shot or cannon balls made their appearance near the end of the fifteenth century; but the use of stone balls was continued because they were lighter, size for size, carried farther, and were cheaper. It is recorded that in 1807, while the English fleet was forcing a passage of the Dardanelles, a stone ball weighing 800 pounds struck Admiral Duckworth's ship and killed or wounded 100 men.

Cylindrical projectiles or shells came into use when the rifling of gun barrels was introduced. Rifled small arms proved their superiority over older types before 1800 and were employed to good advantage by American troops during the Revolutionary War. Those guns continued to utilize round shot, however, until 1828, when elongated bullets appeared. Rifling was not applied to cannon until 1846, when breech-loading guns of that type were developed independently by both Major Cavalli, a Sardinian officer, and Baron Wahrendorff of Sweden. The principles introduced at that time still govern modern gun construction, but the numerous betterments and refinements that have been made since then have resulted in larger cannon and increased the firepower of all sizes.

The manufacture of ammunition for our fighting forces and those of our Allies comprises an important part of our highly ramified production of war matériel. We learned much about the organization of such work during World





SEQUENCE OF FORGE-SHOP OPERATIONS

Square-section, round-cornered steel billets are nicked at regular intervals with a torch, 1, and then broken into forging blanks, 2. The blanks are heated to around 2200°F. in a rotary gas-fired furnace from which they are withdrawn with tongs, 3, and placed on an inclined roller conveyor leading to the forging station. Just short of the first press the blank pauses briefly to have scale removed by a hydroblast at 1100 pounds pressure. The first forging operation is performed in a vertical hydraulic piercing press, 4. There the square billet is transformed into a round section and pierced to form a short, stubby carcass. This is elongated and shaped to final form for machining in a horizontal hydraulic drawing press, 5.

War I and developed successful methods of volume output. This experience enabled us to get a large-scale manufacturing program underway quickly when the present emergency arose. The principal component parts of a round of ammunition for a gun above the small-arms classification are the projectile with its filling, the cartridge, the means of ignition, and the fuse.

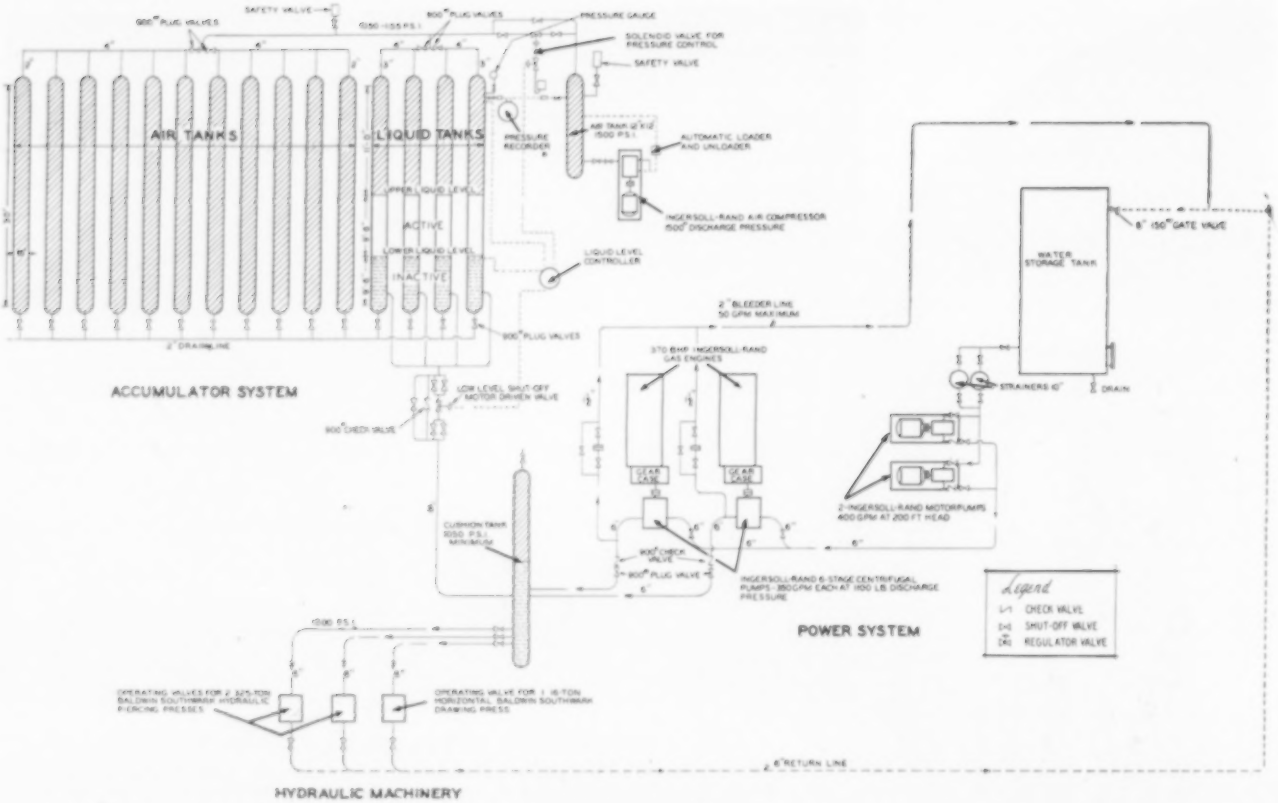
As guns of varying sizes have to be supplied, and there are several types of projectiles in some sizes, it would obviously be a tremendous undertaking for any one concern to attempt to make even one size or type. It would be difficult, if not impossible, to achieve quantity production, and costs would be high. But by breaking down the manufacturing process into various steps, and by allotting the respective jobs to different industrial establishments, it is relatively easy to turn out the constituent parts on a volume basis for assembly at some central point. This is, in effect, the scheme that is followed, with numerous contractors contributing to the work in the several ordnance districts into which the nation is divided. The plan permits each one to develop highly organized methods and equipment for its specific operations, with resultant increases in efficiency and favorable costs.

Among the scores of American firms that are participating in this joint effort is the J. B. Beaird Company of Shreveport, La., which is forging projectiles for 75-mm. and 105-mm. shells from steel blanks and doing the rough and finished machining on them. The company's regular business is the manufacture of high- and low-pressure vessels and other metallic equipment for the petroleum industry and chemical plants. Forging is done in hydraulically operated presses at pressures of from 900 to 1200 pounds per square inch, and pressure is maintained by a hydropneumatic accumulator system that is similar in principle, although different in details, to the accumulators used in steel plants for descaling strip in the continuous manufacturing process.

Forging presses are utilized rather than forging hammers because they have a more desirable effect in working the metal. Hammering affects only the outer surfaces, and the grain refinement is confined almost entirely to the exterior. In the press, on the other hand, the relatively slow, steady advance of a ram exerts a kneading effect, and the strains resulting from the metal's change in shape penetrate very deep. There is also an absence of shock, and this tends to increase the service life of the machinery.

The forging blanks are pieces of billets of square section with rounded corners. Strange as it may seem, these are converted to the circular shape of the shell with less wear on the forming parts of the press than are round sections, and they are more economical in metal. Because of these advantages, and the further fact that square billets cost less than round ones, they are now given preference. The composition of the steel is such as to give the forging the required strength and at the same time leave it readily machinable.

The billets are nicked at measured intervals with an oxyacetylene torch, and are then mechanically broken into forging blanks. These are heated to the prescribed temperature in a Hagan gas-fired rotary furnace. They are fed, one at a time, by a workman using tongs supported near their middle by a chain suspended from an overhead monorail and are removed by another workman with similar equipment. Proper heating is essential to easy and satisfactory forging, and the rotary furnace best answers the requirements. The blanks are progressively heated in passing through three zones, each set for a certain temperature. The proportions of air and gas delivered to the burners in each zone are regulated by motorized valves controlled



FLOW DIAGRAM

Essential features of the hydropneumatic accumulator system that maintains constant water pressure at the forging presses and descaler. The accumulators store energy that can be drawn upon as needed.

by Brown potentiometers. The third zone has temperature-recording equipment. A final temperature of around 2200°F. has been found to be the optimum for easy working, and it also produces a hard, thin scale that can be readily removed. This is important, because scale cannot be allowed to accumulate in the forging dies.

Each heated billet travels down an inclined roller conveyor to a piercing press, pausing for a few seconds en route at a descaling station where it receives from all sides blasts of water under 1100 pounds pressure. This operation is performed so quickly that it does not appreciably reduce the temperature of the metal. The water for the blast comes from the same system that serves the forging equipment. There are various theories as to just how the high-pressure jets remove the scale—the force of the water, the disruptive action of the steam that forms under the scale, and the contraction of the scale when cooler than the billet, all probably enter into the process.

The rough forging is formed in one of two identical Baldwin Southwark 325-ton vertical hydraulic piercing presses. Attached to the down-moving platen of each press is a piercing pot or die in the inverted position. The heated steel blank is placed upright underneath the pot and enters it with a close fit when the platen is lowered by a hydraulic cylinder. Attached to the bottom platen, and centered with reference to the pot, is a stationary piercing mandrel or punch which is forced into the blank as it descends. As the mandrel penetrates the blank, the metal it displaces flows outward and expands the billet, transforming the square section into a round one of the same form as the pot. The downward travel of the upper platen is limited by stop blocks. A mixture of graphite and quenching oil is swabbed onto the dies to lubricate them during the forging operation. The pierced shell block is stripped from the punch on the upward stroke of the press and removed from the piercing pot after the latter has reached its topmost position. Any scale within the pot then falls out by gravity.

The shell carcass thus formed is short and stubby, as compared with its finished shape, and has considerable excess wall thickness. It undergoes further shaping in a Baldwin Southwark 16-ton, horizontal hydraulic drawing press, being still plastic enough to be worked without reheating. The drawing press or bench has a hydraulic piston on the end of which is a punch that enters the cavity of the shell block and pushes the latter through a series of dies of decreasing diameter. The forging comes out elongated and with reduced wall thickness, ready to go to the finishing department. The drawing press is actuated by pneumatic valves that control the direction of the flow of the high-pressure water.

The hydropneumatic system that furnishes operating power for the forging equipment and descaler consists essentially of pumps, an air compressor, and accumulators. An accumulator is a means of storing energy that can be drawn upon when the demand rises above normal. It eliminates the necessity of installing additional pumping equipment and also makes for smoother operation of the hydraulic system. A simple form of accumulator that is sometimes used for pressures up to a few hundred pounds consists of a vertical cylinder fitted with a plunger that is sufficiently weighted to give the required pressure. Water is pumped into the cylinder, raising the plunger and weights. When more water is required than the pumping plant can supply, a valve in the bottom of the cylinder is opened and water from the accumulator flows through pipe lines to the machinery being operated. But in this instance, which calls for higher water pressure and greater volume than can readily be obtained with a weighted accumulator, compressed air maintains the desired pressure on the stored water and acts instantaneously to supply the system with the reserve energy whenever it is needed.

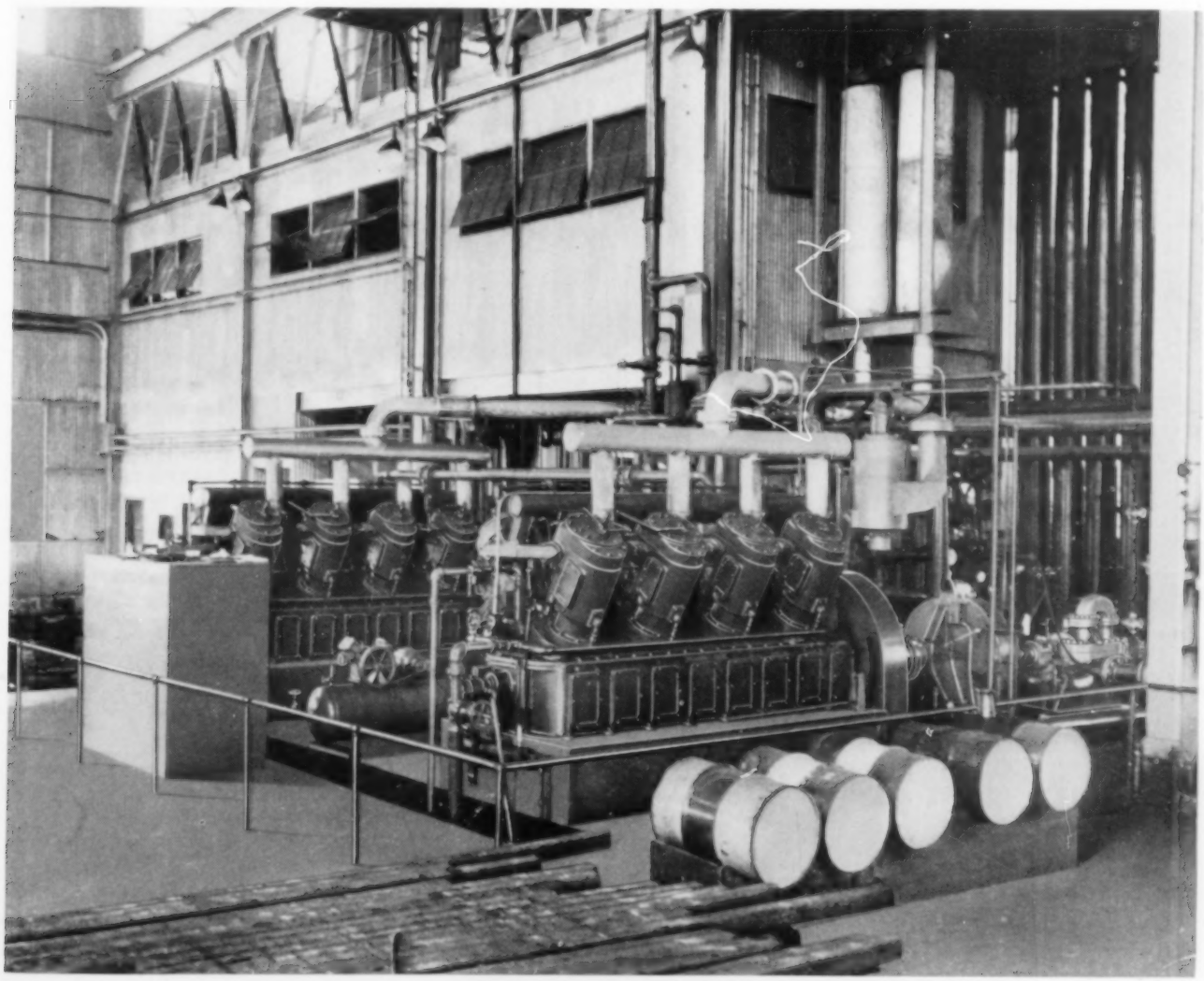
Two Ingersoll-Rand 6-stage, steel-casing, centrifugal pumps operating in parallel each deliver water at the rate of

360 gpm., or a total of 720 gpm., at 1100 pounds pressure into the system. This volume suffices ordinarily, but there are short periods when the demand rises to 1000 gpm. At such times the additional water required is furnished by the accumulators. The latter consist of fifteen steel tanks each 16 inches in outside diameter and 30 feet high and having walls 1 inch thick. Eleven of them contain compressed air at a pressure of from 1050 to 1155 pounds, depending upon service conditions. The four others each have water in the lower section and compressed air in the upper. The height of the water varies from 9½ to 19 feet, and these two levels are called, respectively, the lower liquid level and the upper liquid level. The water between these levels—amounting to 75 gallons per tank, or a total of 300 gallons—is the operating water which is drawn upon when the demand for water at 1100 pounds pressure is greater than the capacity of the pumps. The lower 9½ feet of water, which also amounts to 300 gallons, is called inactive water because the tanks are never drawn down below that level. The liquid level is controlled by a Foxboro Rotax instrument.

When the pumps are delivering more water than is needed for the forging operations, the surplus goes into the liquid tanks. When these are filled to the upper liquid level, compressed air is automatically admitted from the battery of eleven air-storage receivers to prevent the water from rising above the high-level point. When the pumps are unable to supply the demand at the required pressure, the pump discharge pressure starts to drop and the water stored in the accumulators at normal pressure flows into the lines leading from the pumps to the rams, thus motivating them by the force of the expanding air above the water. If enough water is withdrawn to bring it down to the lower liquid level, a motor-driven valve is automatically closed. This prevents depletion of the water supply and keeps the compressed air from entering the hydraulic system. When the pump load is reduced and the pump pressure again returns to normal, excess pump capacity is automatically diverted to recharge the accumulators.

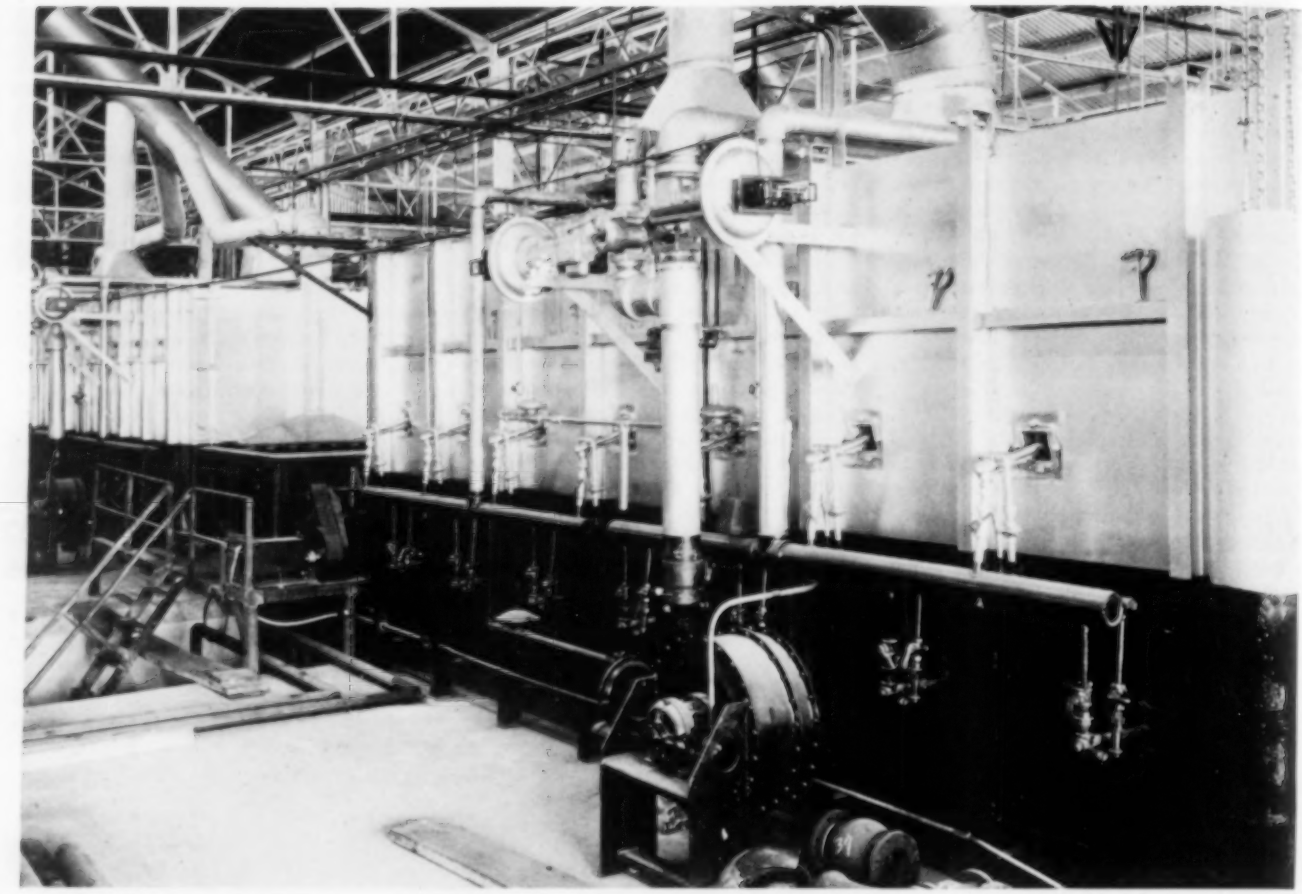
The pumps discharge through two 6-inch lines into a cushion tank, 16 inches in outside diameter and 20 feet high, in the upper part of which is trapped air. Five-inch lines extend from the bottom of this tank to the two piercing presses and to the drawing press, while an 8-inch line leads from the cushion tank to the liquid tanks. The purpose of the cushion tank is to protect the pumps from shock. When shut-off valves are suddenly closed in a high-pressure system such as this, a pressure wave, known as water hammer, is transmitted back through the lines and would damage the pumps if it were not arrested. The compressed air in the tank forms a cushion that dissipates the shock.

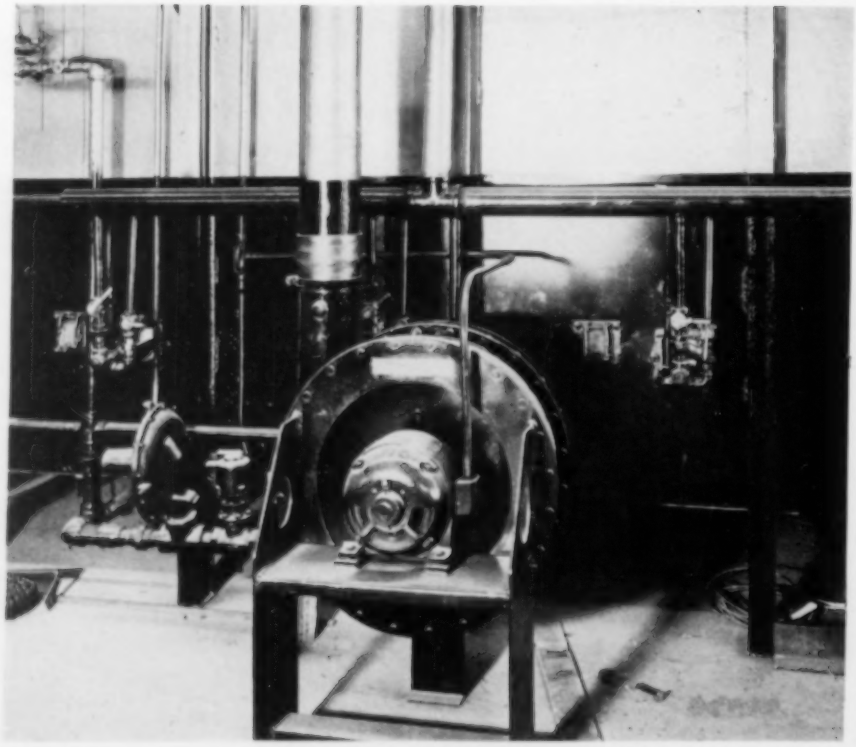
The operating pressure at the presses varies in accordance with the size of the forgings. The 105-mm. shells require



GAS-ENGINE-DRIVEN PUMPS

Two Ingersoll-Rand Type PVG 8-cylinder gas engines, of 370 hp. each, drive through step-up gears two I-R 6-stage centrifugal pumps each of which delivers 360 gpm. of water at 1100 pounds pressure. Between the gas engines is a Type 30 air compressor that serves to start them. The engines use natural gas as fuel.





HEAT-TREATING FURNACES

After being rough-turned, the shell carcasses are conveyed through one of three furnaces, each consisting of two sections. The forgings are preheated in the first section, quenched in oil as they pass between the two sections, and then annealed in the second section. Two I-R Motorblowers furnish combustion air for the burners in each furnace. A close view of one blower is shown at the bottom.

from 1000 to 1200 pounds, while those of 75 mm. need 900 to 1100 pounds. More water must be pumped when the smaller shells are being made because they are produced at a faster rate. The plant was designed for a normal hourly output of 150 Size 105-mm. forgings and a maximum of 180. However, factors of safety were incorporated that have materially increased these figures. The company's original contract covered only 105-mm. shells, the 75-mm. size being added subsequently. The plant ordinarily works on one size for two weeks and then shifts to the other for a similar period. Operations are carried on twenty hours a day.

An 8-inch return line transfers the water from the presses to an open-top storage tank from which it is withdrawn for recirculation through the system, strainers being provided to remove dirt, sticks, etc. Water flows from this tank to two Ingersoll-Rand 40-hp. Motor-pumps which deliver 720 gpm. under 100 pounds pressure to the main pumps. The use of the small boosters not only lightens the load on the main pumps but also assures them water at all times and eliminates possible trouble that might otherwise develop under certain working conditions.

Owing to the abundance of low-cost natural gas in the Shreveport area, it was desirable that the main pumps be operated by gas engines. For several

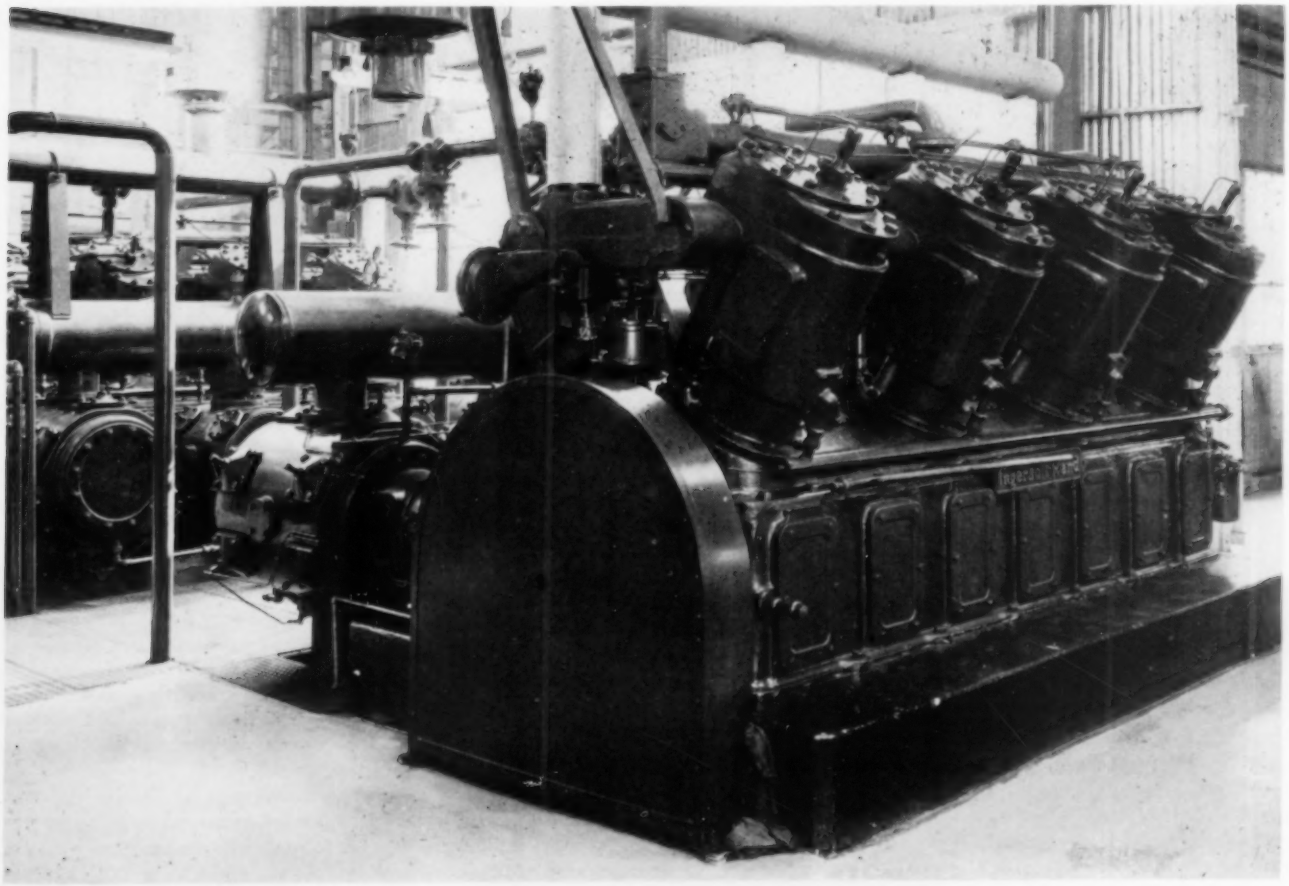
years the company has been getting its plant air supply from four Ingersoll-Rand Type XVG gas-engine-driven compressors, and it selected the same prime mover for the pumps. The engines are Type PVG 8-cylinder units, each of which develops 370 bhp. They normally run at 400 rpm., but their speed can be varied to reduce the pressure in the hydraulic system, if required. As the pumps operate at approximately 3500 rpm., this speed is obtained by Lufkin gears between each pump and its engine. An electric-driven rotary pump supplies oil to each of the gears and is connected in such a way that the engine will automatically be shut down should the pump fail.

A closed system is used for cooling the gas engines, the water going from them through a heat exchanger where it is cooled by counterflowing raw water and then recirculated through the engine jackets. It is circulated by an Ingersoll-Rand Motorpump, a duplicate unit serving as a standby. The volume of water circulated is controlled manually so as to keep the temperature at approximately 150°F. at the jacket discharge. In order to protect the high-pressure pumps from overheating when there is no demand for water at the presses, a by-pass or bleeder line runs from them to the storage tank that supplies the system. It is of 2-inch size and has a capacity of 50 gpm.

Compressed air for the accumulator system is furnished by an Ingersoll-Rand Class ES 3-stage machine driven by a 25-hp. motor. It delivers 48 cfm. at 1500 pounds pressure to a receiver and thence to the accumulator air tanks. The pressure is lowered to the operating level by a reducing valve in the delivery line. The compressor is equipped with automatic stop-and-start control and runs only when there is a demand for additional air in the system. The air required for maintenance of the pressure in the system is only that lost through absorption by the water.

In addition to its use in the accumulator system, compressed air at lower pressures performs essential services elsewhere in the plant. When the shell carcasses go from the forging presses to the machine shop they are first rough-turned and are then conveyed through Lee Wilson heat-treating furnaces. These were designed by Lee Wilson in co-operation with Beaird engineers, who developed the quenching mechanism for this special purpose. There are three of these furnaces, and each consists of two sections. The forgings are preheated in the first section and, after being quenched in oil, are annealed in the second one. Combustion air at a pressure of 0 to 16 ounces is supplied each section by an Ingersoll-Rand Type G Motorblower.

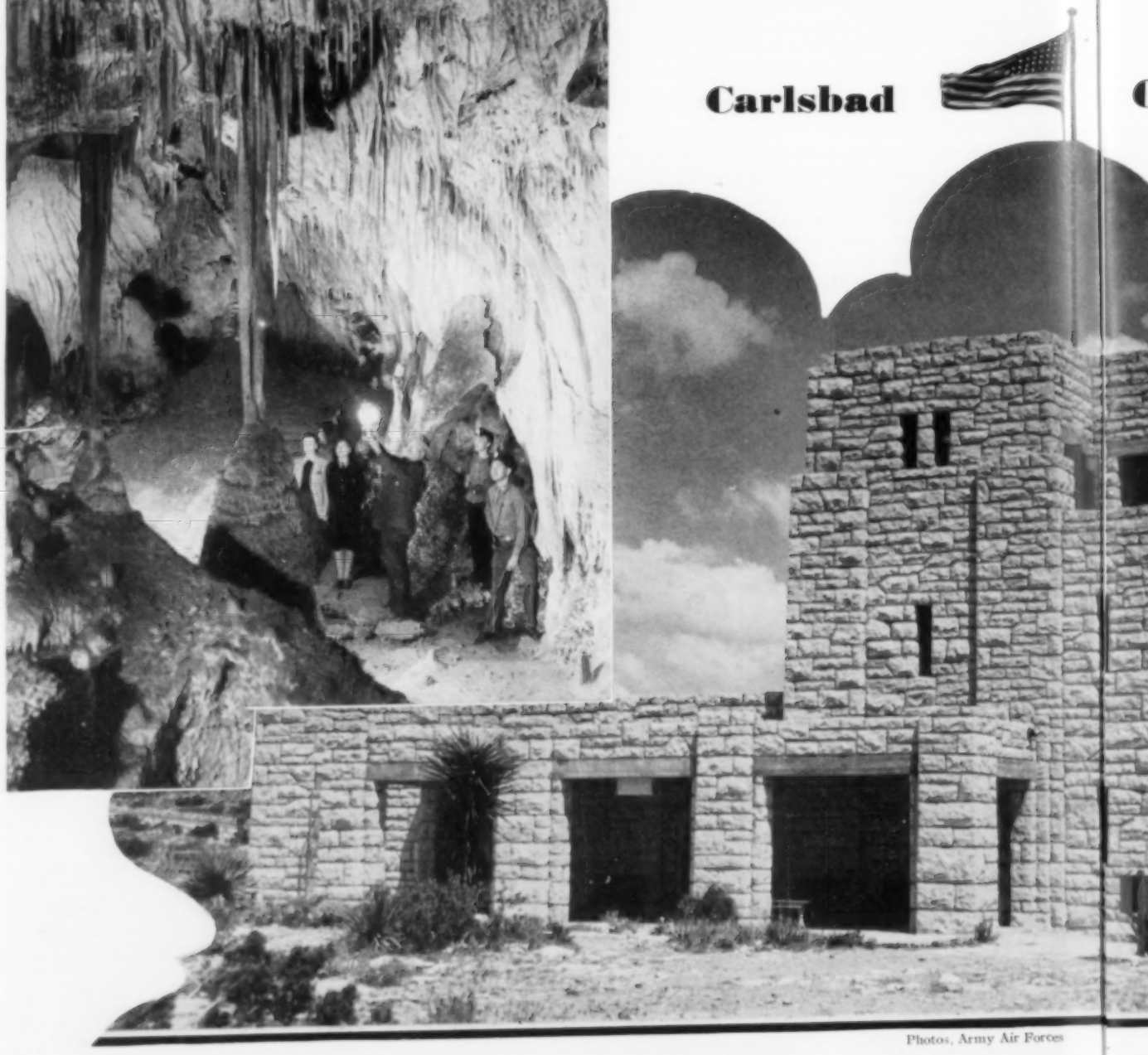
After being heat-treated, the forgings are cleaned by blasting them with crushed steel shot. This is done in three Pangborn units equipped with a dust-collecting system. Each has eight upright spindles on which the forgings are placed while blasting with the air-propelled fragments. Air at 100 pounds pressure is used, and approximately 720 cfm. is consumed when all three units are operating. The air comes from the four XVG compressors which were previously mentioned and which have a combined capacity of 4710 cfm. Air serves to actuate pneumatic chucks on machine tools during the finishing of the forgings and, as one of the final operations, to spray paint the shells, a different color being applied to each type of projectile made in order to distinguish one from the other. The central compressor plant also furnishes air to sections of the plant that are still engaged in the company's regular lines of production.



PLANT AIR COMPRESSORS

Two of the four gas-engine-driven air compressors that furnish air at 100 pounds pressure for general plant use. The engines are similar to those that operate the high-pressure pumps of the hydropneumatic accumulator system.

Carlsbad



Photos, Army Air Forces

WHEN a dog bites a man it's not news! But when 2,219,405 people make a long and dusty trek to Carlsbad, N. Mex., to inspect a hole in the ground that is news in any man's country. That figure is the authentic count of the visitors who have gone through Carlsbad Caverns since records have been kept by the National Park Service. Even now, with a war blazing on three fronts, sight-seers continue to pour into the grottoes, more than 48,000 having made the trip during the first half of 1944.

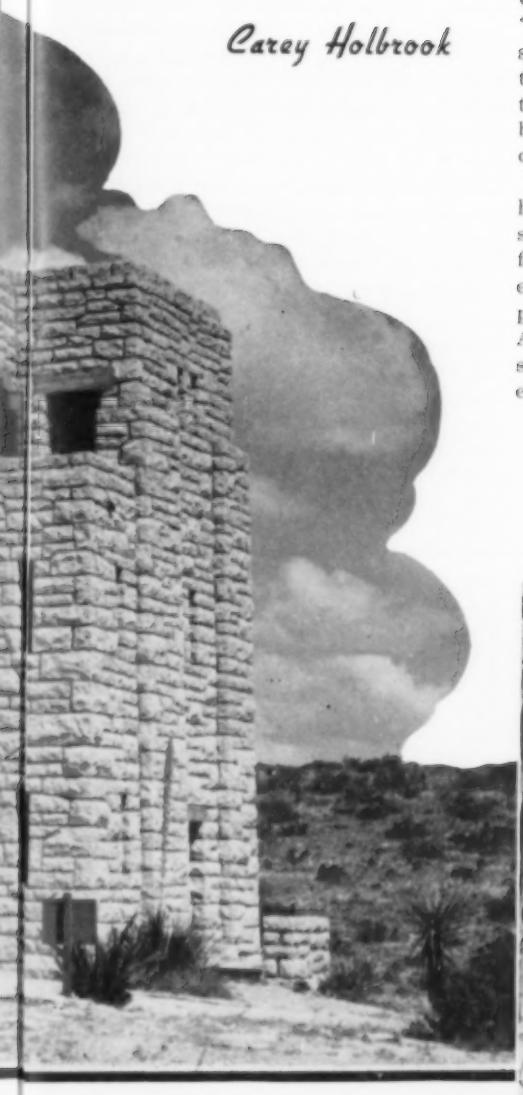
On June 18 of this year, which was a good but by no means a record day, 1074 people went through. They came from Hawaii, Canada, the District of Columbia, and 46 states, making a total of 8380 visitors for the first eighteen days of the month. In the group were 427 soldiers, bringing the number of members of the armed forces during those weeks in June to 3228. Leaders on the eighteenth were Texas, 261; New Mexico, 145; California, 93; and Illinois, Minnesota, and New York, 40 each.

It was in 1901 that a young cowboy named Jim White first became curious about a mysterious opening in the earth from which a swarm of bats emerged each evening. With a Mexican lad as his only companion, Jim started in to investigate the hole, and to his amazement discovered that a maze of winding passageways led from it far into the earth. For many months the pair explored the underground wonderland, sometimes taking along provisions and remaining for days in the caverns. Smudge marks on the walls, and long lines of white string helped them to find their way back to the opening. Each trip they made gave them a fresh view of new and mighty rooms with high and vaulted ceilings, lacy formations of rock, and huge columns built by a trickle of water that had dripped for thousands of years. Each exploration made Jim more sure that he had stumbled upon a natural wonder surpassing anything of its kind.

As the weeks went by, White installed a crude bucket-and-rope hoist to enable visitors to make the descent more easily, and he lost no opportunity to take his friends into the hole for a look at the wonderful caverns he had discovered. In 1923 he interested the U. S. Geological Survey in the project, and during that

Caverns

Carey Holbrook



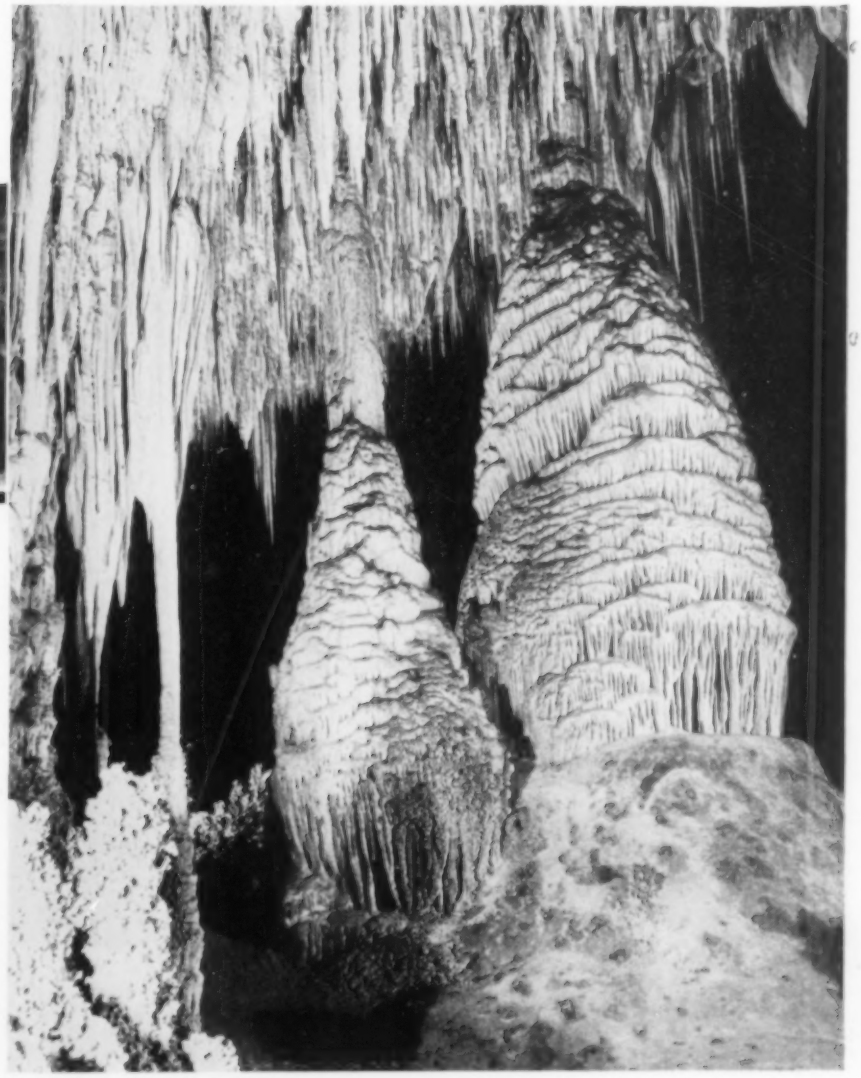
year Robert Holly of the General Land Office and Dr. Willis T. Lee of the Geological Survey made an examination that resulted in an expedition sponsored by the National Geographic Society. The resulting report, published in the National Geographic Magazine of January, 1924, gave the caves national publicity.

Carlsbad Caverns was proclaimed a National Monument by President Coolidge on October 25, 1923, and the area was created a National Park by act of Congress on May 14, 1930. At that time it covered only a small space, but since then it has been expanded until now the Carlsbad Caverns National Park embraces 49,568 acres. Within its confines are located scores of grottoes of various sizes, most of them unexplored. The openings are made by the action of water in a massive limestone formation that was laid down in a shallow inland extension of the ocean some 200 million years back. The uplifting and folding movements that created the Rocky Mountains also raised the Carlsbad area above sea level. All this took place about 60 million years ago at the end of the "Age of Dinosaurs." Since then the streams have carved their deep gorges, the vast caverns have been hollowed in the limestone, and within them have been formed the amazing decorative deposits.

Many changes and improvements have been made in the Carlsbad Caverns since Jim White first lowered his lean frame gingerly into the gaping hole in the earth. Modern facilities have been provided and foot trails have been built. An electric-lighting system has been installed, along with a modern passenger elevator that whisks visitors up and down in jig time. But the New Mexico sun still blazes down fiercely on the pilgrims preparing to make the descent along the winding stairways and crooked passageways that lead to the wonders below. Slowly they form a long line at the entrance, led by a guide in uniform and chaperoned by other guides spaced at regular intervals along the line. Among them, clad in stout boots, are a couple of school teachers from Boston, Mass.; a delegation of vacationing policemen from New York City; a man and his wife from Magnolia, Ark.; and always a crowd of longhorn citizens from Texas. All pour into the caves in an endless stream. A cool breeze from the mysterious depths below fans their faces as they start down the first long stairway, and they cling to banisters worn slick by the clutch of nervous hands. The light now is a kind of smoky dusk, while behind them the opening shrinks and fades into a faint glow. With the spell

UNDERGROUND FAIRYLAND

At the far left is the "Temple of the Sun," 750 feet below the surface. The building in the center houses the headframe and operating machinery of the elevator that eases the journey of sight-seers. Below, dancing light is reflected from a vaulted ceiling of lacy spires.



of the caverns upon them, conversation comes in jerky spurts, with an occasional shrill laugh halted in midair. "It's right purty further down," the tall guide in a flat hat says in a soft Southern drawl, and the couple from Magnolia glance at him gratefully, hungry for the sound of a voice from home. As darkness deepens, the long line falls silent, moving ever downward along the twisting stairs lighted only occasionally by a hidden electric globe.

Some idea of the immense area of the corridors and openings in the Carlsbad Caverns may be obtained from the measurements of what is known as "The Big Room." This chamber is 4000 feet long and has a maximum width of 625 feet. The average height of the ceiling is 200 feet, although there are points where it is much higher. The floor space is about 57 acres in extent and could accommodate seats for 500,000 people or, roughly, the entire population of the State of New Mexico. Within this room is "The Giant Dome," a massive formation 62 feet high, 16 feet in diameter, and estimated to be 60 million years old. Here also is the huge "Rock of Ages" at whose base each party of tourists pauses to rest while every light is extinguished. This is no ordinary blackness. Around them is a deep, impenetrable Stygian night out of which comes the swelling notes of a pipe organ that go echoing along the mighty corridors until even the most hardened individual finds his eyelids wet and his lips forming the words of that ancient and soul-stirring hymn, "Rock of Ages, cleft for me, let me hide myself in Thee!" Then, as the notes die away and back in some hidden recess an electric light winks into life, the silent throng gets quietly to its feet and, still under the spell of that sacred moment, moves silently into a brightly lighted and spotless dining room provided with tables and chairs for the noonday lunch. "It's a right smart walk down this far," the tall guide remarks, and the man and his wife from Magnolia make room for him at their table.

More than 40 years have swept by since Jim White discovered the Carlsbad Caverns, but the bats that attracted him continue to occupy their underground home in never-decreasing numbers. From October until April the creatures hibernate, hanging head down and seemingly lifeless from the walls and ceilings of a long corridor that extends ¼ mile eastward from the main entrance and that is not open to visitors. During the other months they roam the countryside, swarming out at night to prey on insects and returning before dawn to their roosts 180 feet below the surface.

Beginning about sunset, the bats come pouring forth from the entrance in a spiral stream that looks like water flowing over a dam. The mass is seemingly unending and unbroken, and it takes at least three hours for the entire colony to get out of the cave. It has been estimated that three million of the creatures take wing and that they devour in a night's operations a little more than 11½ tons of insects, including moths, beetles, flies, and mosquitoes. Five kinds of bats are represented, but by far the most numerous is the Mexican free-tailed bat which gets its name from the fact that its tail projects about an inch beyond the skin that stretches between the hind legs.

The actual size of the Carlsbad Caverns is not yet known, although many miles of passageways have been penetrated on the three main levels. The first is 740 feet underground. At a depth of 900 feet is a vast subterranean apartment, and 420 feet below that is still another. None of these levels has been completely explored. The dining room and all other improvements to take care of visitors is on the 740-foot level, and it is this one that is open to the public.

As the line of tourists moves out of the dining room, it is once more walking in a fantastic and unreal world. "If you will look down yonder," the tall guide says, "you will see a right clear little creek," and the white beam from his torch bores through the blackness into a crystal pool, sending up dancing reflections that bounce off a vaulted ceiling of lacy spires and sweep away into the purple shadows until they are lost in a fairyland of unbelievable formations. "I used to work in Magnolia," the guide comments, but the man from Magnolia makes no answer, for around him is a strange and breath-taking world. Behind him somewhere, a long time ago, he drove a car across a white road under the glare of a burning sun. Behind him somewhere, a long time ago, he sat on a white porch beneath a honeysuckle vine while a mocking bird poured out its heart. Behind him there are cities, and

NATURE'S HANDIWORK

Massive formations that were formed through the ages by trickles of water. The limestone in which the caverns have been carved is estimated to be 60 million years old. The people in the picture assume the proportions of pygmies.

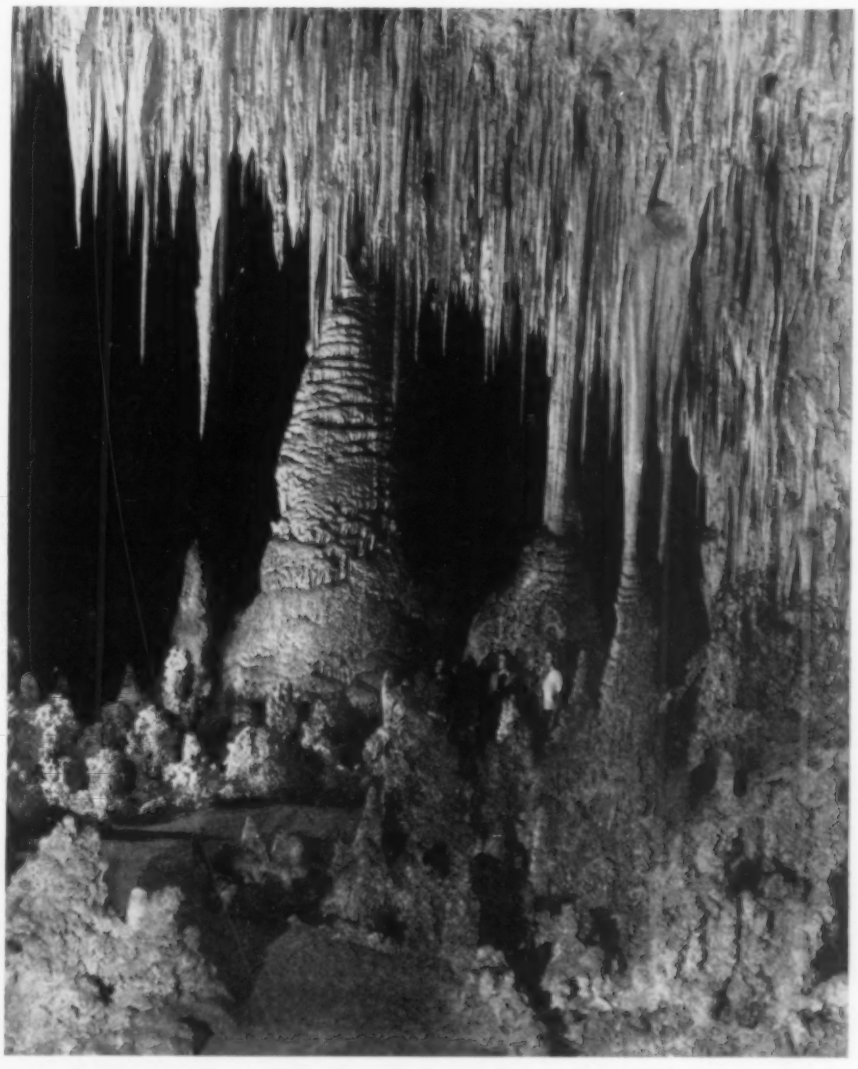
people, and hot-dog stands, but that was a long time ago and has no connection with this spectacle his eyes are looking on.

The trip through the Carlsbad Caverns covers a distance of approximately 7 miles, and after the inspection an elevator carries the sight-seers back to the surface. Work on the shaft started December 29, 1930. The first person to use it was the famous humorist Will Rogers who visited the caves with his wife a few hours after the shaft was blasted through, in May of 1931, and made the descent in a bucket on the end of a rope. The elevator was completed and put in operation on January 23, 1932, when Governor Seligman and 150 members of the New Mexico Press Association were guests of the National Park Association. Governor Seligman acted as elevator boy for the first several trips, handling the controls and opening and shutting the doors. Frank A. Kittredge, chief engineer of the National Park Service, and his associate, Walter G. Attwell, had charge of the installation of the elevator, and their report of this engineering feat in the *Engineering News-Record* of June 9, 1932, included the following passages:

"Location of the elevator shaft was dictated by the necessity for making the lower end accessible to the main trail and major formations. Selection of this point and the desirability of sinking and raising the shaft at the same time necessitated an accurate survey up the circuitous trail to the surface. This survey was run in three independent traverses, with methods similar to usual mine-survey procedure.

"The traverse line started at the base of the elevator-shaft location and extended over cliffs, through dark passageways and tunnels to the mouth and then to the position at the top of the shaft. Before starting instrument work, permanent brass monuments were concreted into the solid rock at angle points and bench marks. The engineering party rotated positions on the different traverses to lessen the chance for repetition of errors. Angles were turned four times with an ordinary mining transit, and vertical angles were read to the minute. All distances were chained on the slope to the nearest hundredth of a foot. Slope distances as measured were corrected for sag and a constant factor of temperature since the air in the cave remains unchanged at 56 degrees throughout the year. Outside the temperatures were about 20 deg. when the surveys were made in January, and corresponding corrections were made. Completion of the shaft indicated a closing error of 0.02 Ft. horizontally and 0.01 Ft. vertically.

"Working three shifts a day from top and bottom, driving operations were carried on without an accident, and met



A CATHEDRAL IN THE DEPTHS

"It's right purty farther down," the guide says, and this picture confirms his words.

450 ft. below the surface. The shaft size was 6 ft. 10 inches x 14 ft. 3 inches inside the concrete lining. Blasting rounds consisted of 36 holes taking out an average lift of 5 ft. The 4000 cubic yards of limestone excavated were removed with an average of 6 lbs. of explosive per cubic yard without injuring any of the formations in the adjoining rooms. The rock consisted of limestone in horizontal planes and was badly eroded. Small passageways a few inches in diameter caused much steel to be broken and many shots ineffective. This feature made drilling slow and costly.

"The shaft was lined with gunite varying in thickness from ¼ inch to several inches. The lining is principally to prevent weathering with possible displacement of loosened fragments. The gunite was mixed in proportions of one of cement to three parts of sand, with 4 percent of calcium chloride added to hasten set.

"The steel headframe is the center of a 3-story shaft house. The first floor is occupied by the elevator landing, the second floor is used as a generating room, and the third contains the machinery and controls. The elevator is of modern electric type, with self-leveling cage carrying twelve persons, and operates at a speed of 700 feet per minute. With the exception of a few elevators in the Empire State Building in New York City this installation is the longest single-lift passenger elevator in the world. The equipment contains all automatic safety devices found in usual building installations."

The Carlsbad Caverns National Park is in charge of Col. Thomas Boles, who has been superintendent for many years. It is open every day in the year for visitors, who pay $1.50 each for guide service. There is no fee for children sixteen years of age or under when they are accompanied by adults taking full responsibility for their safety and good conduct. A charge of 25 cents each way is made for every adult using the elevator.

Official Photos from U. S. Air Forces

ANCIENT METHODS BUILD MODERN AIRFIELDS

ONE of the anomalies of the war is the use of Chinese manual labor to build landing fields for the largest and most modern bombers that fly —the B-29 superbombers. Some of the air-base sites are former rice fields. After they were purchased from Chinese farmers, the latter and neighboring townspeople were recruited to do the necessary construction work under the supervision of USAAF aviation engineers. Each village contributed its quota of men and women, mules, wheelbarrows, carts, and implements. Some of the workers came from as far as 150 miles away—on foot. These pictures illustrate various phases of the operations at one field.

1- Airplanes are such common sights that these workers did not even glance upward when a C-46 Commando passed overhead.

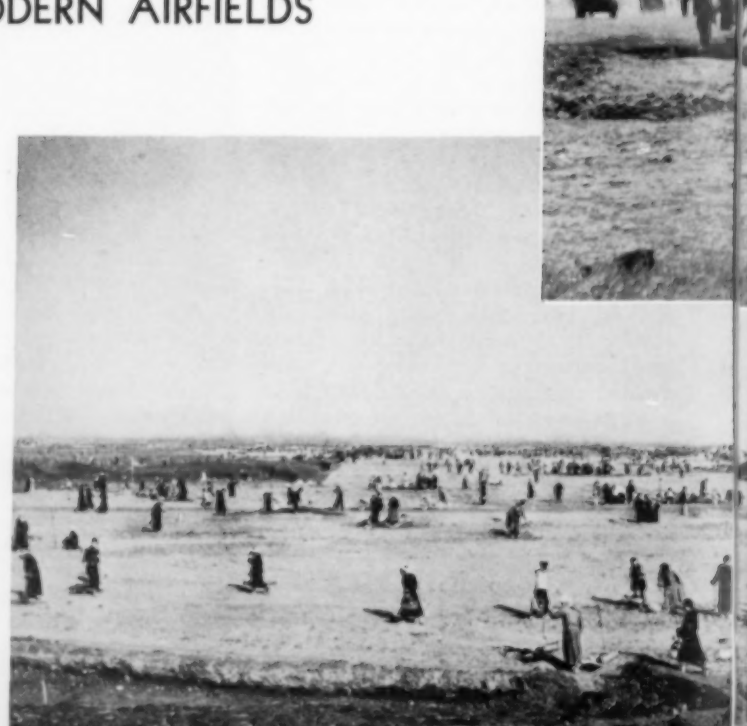
2- A 4-manpower pump for handling water.

3- Women breaking stones with hammers to produce paving materials.

4- Farmers using the same implements for construction as they do for tilling their ancestral lands.

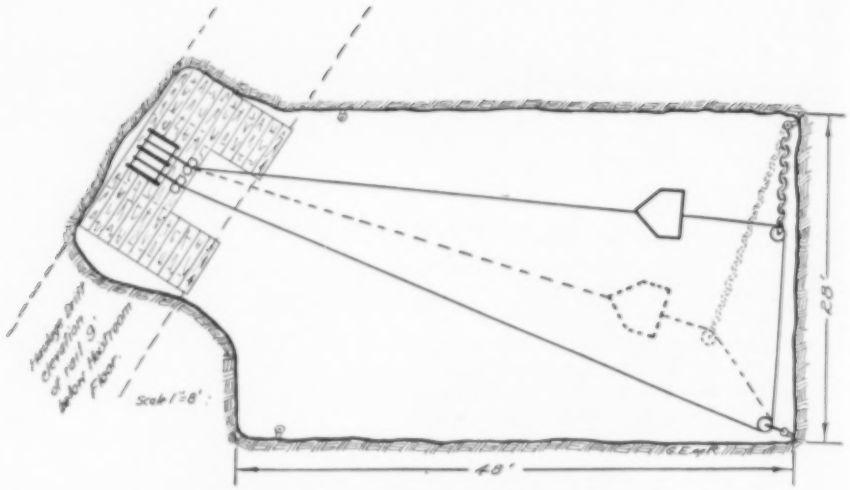
5- Hordes of laborers moving dirt in wheelbarrows and primitive shoulder-carrier baskets to make a turning circle at one end of a long runway.

6- Engineers started to use an old German steamroller, but they had to stop because it retarded progress. The Chinese ceased work and followed the machine.



Slushing at Britannia Mines

T. M. Waterland*



EXTENSION CHAIN FOR TAIL SHEAVE

This sketch shows a method that permits mucking a large space with a 2-drum hoist. It eliminates the necessity of placing a series of eyebolts across the face. By extending the chain, as illustrated by dotted lines, the entire face can be covered and it is possible to draw the scraper all the way back to the face and thus remove the last remnants of broken material.

SLUSHER hoists have been in service at the several mines of the Britannia Mining & Smelting Company for a number of years. In one working, scraper loading was used with success in driving the major part of a 20,000-foot haulage tunnel on the 4100 level, and on a number of occasions broken ore has been slushed from draw points to transfer raises. These operations were in no way unusual, but during the past two years several new problems in scraper mining have come up that may prove of interest to readers of this magazine.

Of particular interest is the method adopted for attaching the tail-rope block when slushing out large underground openings such as hoist rooms, shaft stations, and square-set stope sills. Scraping broken rock out of a wide face becomes a tedious job where new anchorages must be provided when the path of the scraper has to be changed. Putting in a series of eyebolts across the face is effective but slow, and moving the block along a chain anchored across the face is ineffective because the scraper cannot be drawn close enough to the face to remove the last of the broken rock. Under such circumstances it becomes necessary to muck back by hand before setting up for the next round.

While studying such an operation it occurred to the writer that it might be feasible to secure the tail block to the end of a chain anchored in one corner so that by letting out the chain the block could be shifted across the face as required. Accordingly, an eyebolt was set in each corner of the face to be mucked out. To one of these the block was attached directly and to the other by means of a chain. The latter had a grab-hook at each end so that it could be shortened or lengthened readily. The haul-back cable was then passed through both blocks, as shown in the accompanying sketch. The method proved successful. The block could be moved quickly to any position along the face. This enabled the operator to scrape more evenly, to avoid making the usual ridges and troughs along the floor. He also found that he was able to slap the scraper up against the face and thus remove the last remnants of broken rock. The sketch illustrates the set up used when scraping out a 28x48-foot hoist room. Only four eyebolts were needed to make the final cleanup.

Square-set stoping has been the standard method of ore extraction at the Victoria Mine for more than twenty years. The ore is of relatively high grade and capped with a heavy overburden of glacial till, which provides a cheap supply of excellent fill. But mining of the No. 5 Ore Body by square-set stoping presented a problem because the ore is of considerably lower grade and fill is not readily available. The ore is reasonably firm, lies nearly vertical, and in the section under consideration was about 50 feet wide. The wall rocks consist of very soft highly altered schists.

Several blocks had been mined as shrinkage stopes, but before all the broken ore could be drawn out, the footwall collapsed and caused excessive di-

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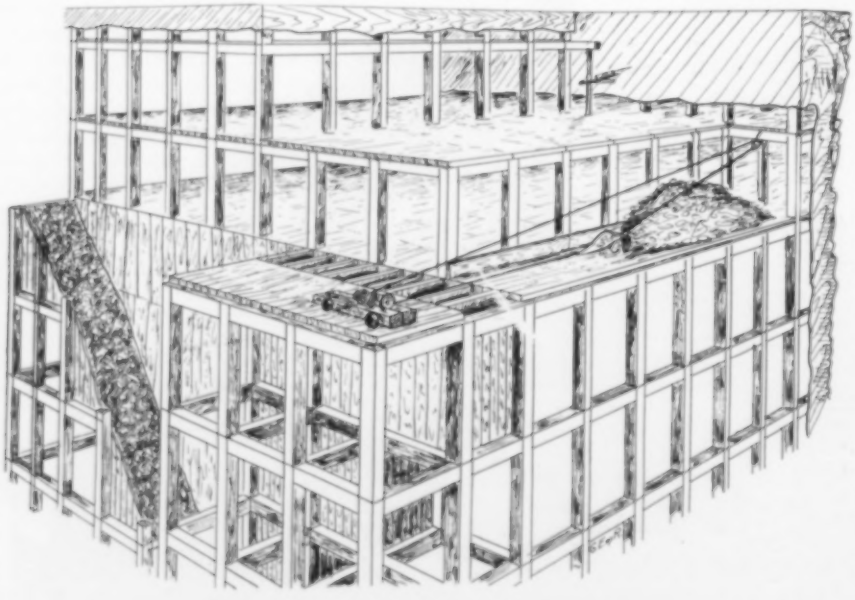


SCRAPING IN AN OPEN SQUARE-SET STOPE

A double-drum 7½-hp. hoist is mounted on flangeless car wheels, making if possible to move the outfit quickly from one lane to another as mucking proceeds. All muck is scraped back to a chute near the end of the stope.

lution. Cut-and-fill methods proved unsuccessful. Square-set stoping was then considered. To be satisfactory, it would have to be open or unfilled because the cost of filling would be excessive. A shell of ore would have to be left along the soft walls against which the timber could be blocked. This would also help to prevent ground movements from starting. With open square sets a block could be mined more quickly and thus further minimize the danger of ground squeeze.

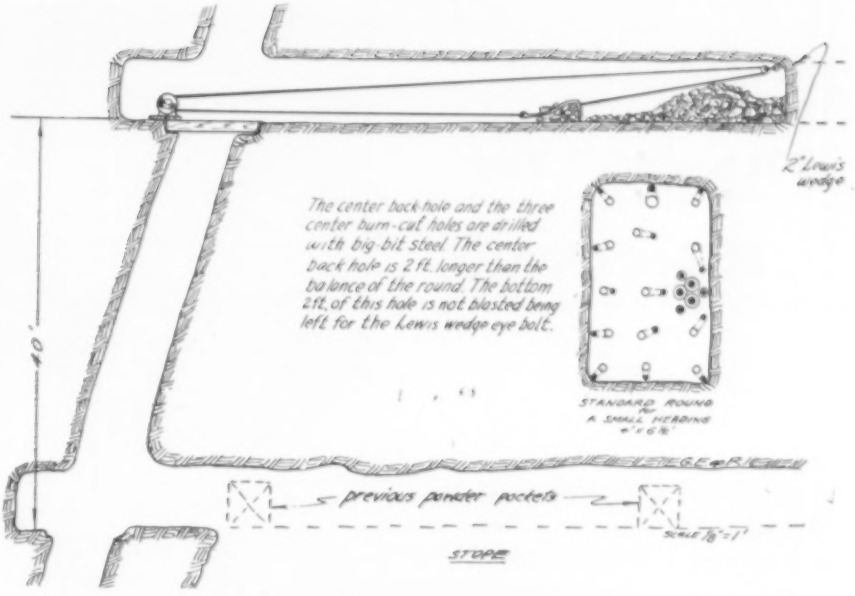
The stopes were begun as hand-mucking operations with chutes at close intervals. The largest stope was seven sets wide and sixteen long. Because of the necessity of light blasting in unfilled square-set stopes of this size, poor fragmentation resulted, and when the broken ore was let down from the mining floor to the mucking floor the clearing of the grizzlies was a slow and difficult job. Scraper mucking seemed to be the solution of the problem. A 7½-hp. double-drum, Ingersoll Rand air hoist was available, and this was mounted on two 10x 10-inch timbers, 7 feet long, supported on a set of old 1-ton car wheels from which the flanges had been removed. The ensuing slusher operation proved to be very successful.

Scraping was done parallel to the walls and down each row of sets to a chute near the end of the stope. This chute was winged from footwall to hanging wall, as shown in the sketch, and covered by a timber grizzly. Toe boards were spiked along the bottoms of the posts to prevent the latter from being snagged by the slusher. Through the introduction of the scraper, mucking was speeded up so much that it no longer delayed the other work. The hoist was held firm by means of sprags and could be moved and reset in an adjoining row in twenty minutes by one man. Slushing at the rate of 35 tons per hour was not uncommon. Boulders too large to pass through the grizzly were rolled to one side, blockholed, and then blasted at the middle or at the end of a shift. The mining floor was cleared early in the shift so that mining and timbering were not held up to any considerable extent. The elimination of all but one set of chutes reduced the time spent on timbering. Scraper mucking increased output per labor shift appreciably. Production in excess of 6 tons per labor shift was maintained for a 12-month period. This included all work such as mining, timbering, mucking, and nipping of supplies in any way connected with the stope.

Most of the ore breaking in the Bluff Ore Body is done by powder blasting. This entails driving a number of sublevel drifts or crosscuts from wing raises above the stope undercuts. They are usually as small as possible, and until recently the broken rock from the development rounds was removed by hand mucking and wheelbarrow tramming. With drifts often more than 100 feet in length, the operations were consequently slow and tedious.

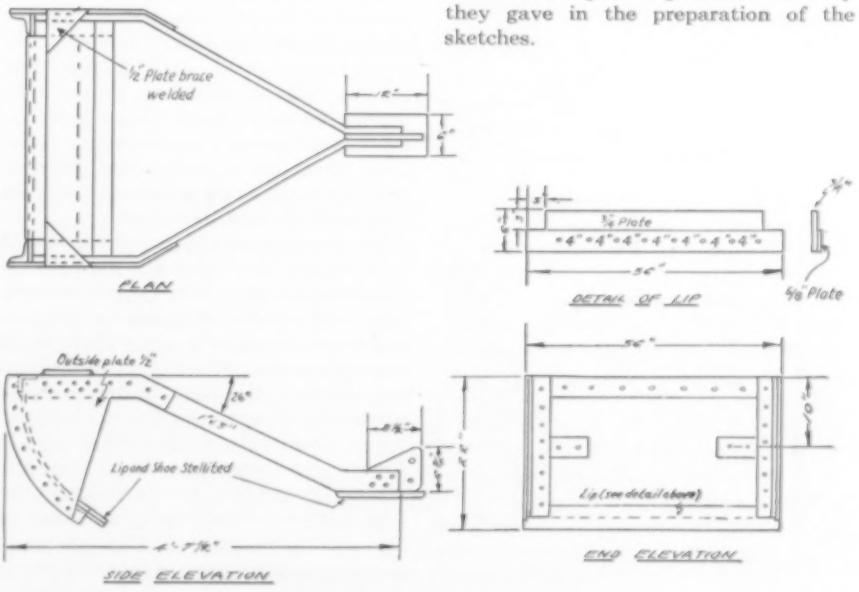
As an expedient to offset the manpower shortage, a small slusher was introduced for removing the broken rock from such headings. A double-drum hoist was set up in a stub heading driven from the opposite side of the raise from which the sublevel was collared. (Note sketch.) All development muck was then slushed from the face with the same type of light scraper used in square-set stoping. The result was a much more efficient operation. The slusher speeded up the work, eliminated the drudgery of hand mucking and wheelbarrow tramming, and in comparable headings increased the advance per labor shift from 1.89 to 3 feet.

The writer wishes to thank the management of the Britannia Mining & Smelting Company for permission to publish this information and the members of the engineering staff for the help they gave in the preparation of the sketches.


2" Lewis wedge
The center back hole and the three center burn-cut holes are drilled with big-bit steel. The center back hole is 2 ft. longer than the balance of the round. The bottom 2 ft. of this hole is not blasted being left for the Lewis wedge eye bolt.
STANDARD ROUND FOR A SMALL HEADING
40'
previous powder pockets
STOPE

DRIVING A POWDER-BLAST SUBLEVEL

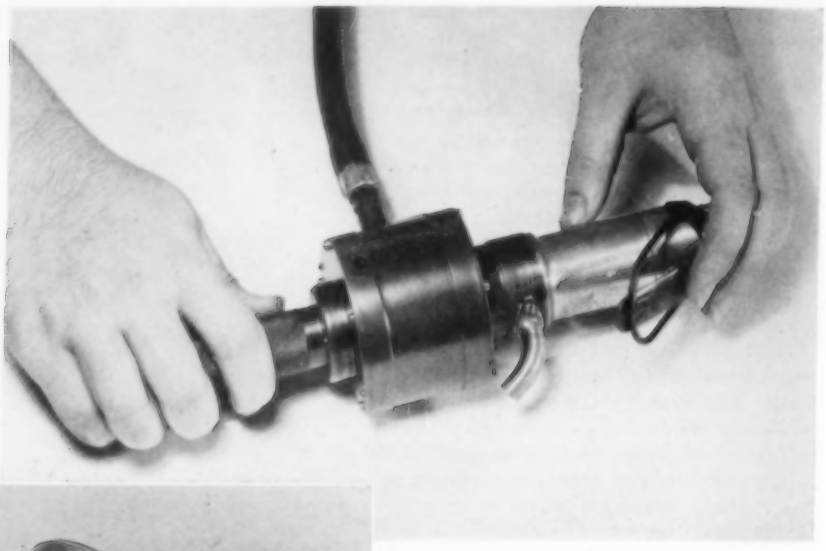
This sketch illustrates a mining method that is used in only a few properties. A block of 40 feet of ground vertically is developed by driving small sublevels from which crosscuts are driven to the hanging wall and footwall of the vein and loaded with powder for blasting. By using a small hoist and scraper instead of hand shoveling and wheelbarrows the drifts can be driven at a faster rate and production obtained sooner.

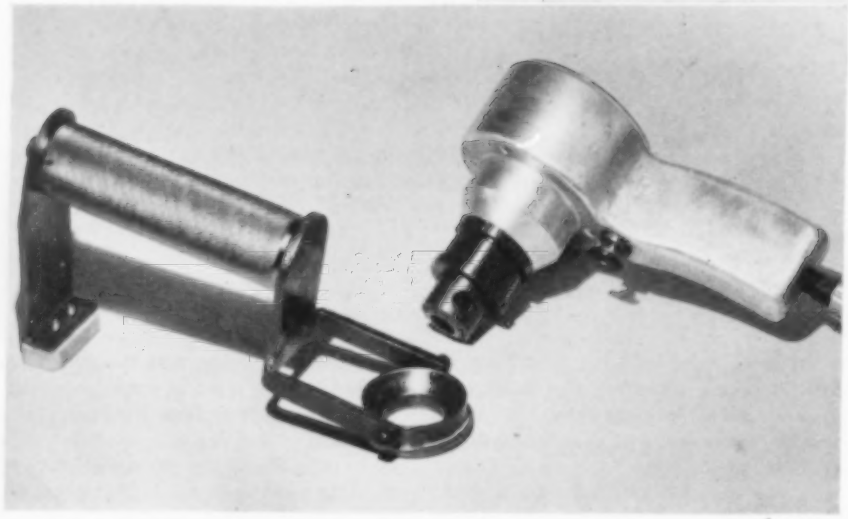


SCRAPER CONSTRUCTION

Details of unit used with a 7½-hp. hoist. The scraper weighs 370 pounds.

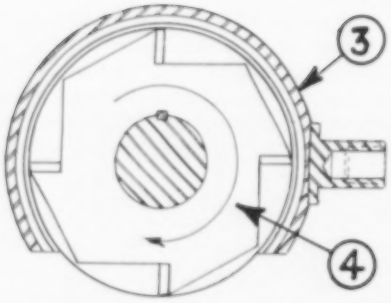
Air-Operated "Razors" for Rivet Heads

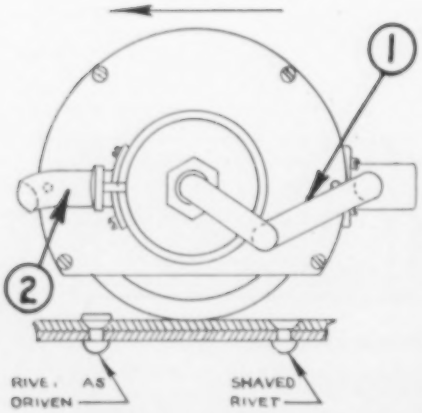




SHAVE OFF RIVET HEADS

At the left is the Rivet Finisher, which is driven by an air turbine and used in connection with a stabilizer that holds the cutter to the work. Together, they weigh 4½ pounds. The shaver, top, which removes more than one rivet head at a time, is operated by an Ingersoll-Rand air motor. The housing of the latter, at the right in the picture, serves as one of the handles by which the tool is guided, and the air hose is centrally connected to prevent off-center pull. Both milling tools use air at from 90 to 100 pounds pressure, and the chips are blown from the work with the exhaust air. Drawings show details of the Rivet Shaver: 1, air inlet; 2, air exhaust; 3, housing; 4, cutter.





TO PROVIDE aircraft with surfaces of maximum aerodynamic smoothness and structural tightness, the Pfahler Manufacturing Corporation has recently introduced a new type of portable air-driven milling tool that supplements the pneumatic riveting hammer. Thousands of aluminum-alloy rivets are used in the construction of an airplane, and they are generally countersunk so as to be flush with the surface. Because of unavoidable tolerance requirements, however, rivet heads sometimes protrude, and in the case of a seaplane they are purposely allowed to project.

By the new procedure, which is said to provide a craft that is in no way deficient in respect to aerodynamic smoothness and structural tightness, all the rivets are driven with some of the head material protruding. The excess is then cut off, and this work is done by the new tools. They are known as the Shego Rivet Shaver and the Shego Rivet Finisher and are designed to meet the special needs of the production line, the type used depending upon the gauge of the metal being riveted. The Shaver is suitable for heavy-gauge material which does not develop wrinkles during riveting and consists essentially of a tungsten-carbide-tipped milling cutter that is driven by an Ingersoll-Rand air motor at speeds up to 20,000 rpm. It is gripped at both ends by a handle and by the motor housing and is rolled over the rivet heads by the aid of wheels. These are mounted on ball bearings and can be adjusted vertically to regulate with precision the clearance between the cutter and the plane surface. Chips are blown out of the path of the disk by the exhaust air. The tool comes in two sizes weighing, complete, 5½ and 9½ pounds. They are designed to mill rivet heads or other aluminum-alloy protruberances up to ⅜ and up to ¾ inch in width, respectively.

In order to obtain a close shave without scraping the skin it is necessary that the latter be free of wrinkles. Thin-gauge metals, however, do not always remain smooth during riveting, and it was for work on skin of this kind that the finisher was developed. It is designed for spot-facing, that is, to remove each rivet head separately, and operates in conjunction with a stabilizer that holds the cutter to the work. The latter is driven by an air turbine and is controlled by an adjustable stop which permits it to machine the rivet head until it has been removed flush with the surrounding surface.

This and That

Pressure Activates Photo Film

Treatment of photographic film with compressed gases increases its sensitivity to light, according to a Chinese scientist, Choong Shinpiaw, of the Institute of Physics, National Academy of Peiping at Kunming, China. Reporting in the *Journal of the Optical Society of America*, he writes of experiments in which he subjected film to nitrogen and carbon dioxide under 2000 pounds pressure and to hydrogen under 400 pounds pressure. An increase in sensitivity resulted when the film was treated prior to exposure. When pressure was applied during exposure, an increase in sensitivity was obtained with hydrogen but not with the two other gases. No change was brought about by any of the gases when pressure was applied after exposure. The author does not advance any explanation of the phenomenon he observed.

* * *

Fishes Without Loaves

In World War I, the doughboy's dietary included considerable salmon (Columbia River turkey the boys called it). No doubt G. I. Joe in this war is getting goodly quantities of the same fish, judging by its comparative absence from shop shelves. However, the smaller sardine also rates high on the list of edibles. Coördinator of Fisheries Harold L. Ickes has announced that fishing for California sardines will again be under Federal control this year, commencing August 1. Uncle Sam steps in to make sure of the desired catch, that the fish will flow evenly into the various canneries and processing plants, and that they will come forth in the desired quantities of canned fish, meal, and oil. This control is exercised by requiring purse seiners (the type of vessel normally used to fish for sardines) to take out licenses. Many purse seiners customarily go north into Alaskan waters in early summer for halibut and sometimes don't get back in time to go after sardines. This year the halibut season started late, and unless the Government directs the movements of the seiners it is feared that the sardine catch will fall short by as much as 11,000 tons.

The sardine is a desirable food fish in wartime because of its high nutritive value, low cost, and ready transportability in the canned state. The sardine of commerce may be any one of several varieties of fishes, all of which are the young of the herring family. The true sardine is technically the *sardina pilchardus*, or pilchard, and is found only in European waters north of the English Channel. It attains a length of 10 inches, and the adult fishes are caught off Cornwall and salted down in barrels. The sardine of the Mediterranean area (named for the Island of Sardinia) is a smaller creature. Elsewhere in the world, immature pilchards of different species are sold as sardines, and in some localities young menhaden end up under the same label.

The coastal waters of California, Oregon, and Washington yield pilchards in such quantities that they approximate in weight one-fourth of all U.S. and Alaskan fish landings. This year 55 percent of the pack will be reserved for government purchase, and the Coördinated Pilchard Production Plan will oversee its destiny. Owners of purse seiners who are ordered to transfer their activities from halibut to pilchards will face a fine or suspension of their licenses if they fail to comply.

Purse seiners are so named because they employ a purse seine to catch the young pilchards. The net is from 250 to 400 yards long and from 13 to 20 yards wide. It is paid out into the water with floats attached to the upper edge and brass rings to the lower. The two ends are brought together to surround a school of fish, after which a line, threaded through the brass rings, serves as a pucker string to close the bottom of the net and to imprison the fish. This operation is performed by passing the line through pulleys on a heavy lead weight, called a ton, which is thrown overboard. As it sinks, its weight quickly gathers the bottom of the net together.

* * *

Madeline Befriends G. I. Joes

During the pursuit of the German forces by the Allies in North Africa, bridges demolished by the foe had to be quickly replaced, and our Army Engineers were busy, to say the least. One of the platoons engaged in this work had a gasoline-engine-driven air compressor mounted on a truck, and it proved of such help that a member of the crew christened it Madeline, in honor of his girl back home. The name stuck, and thereafter the unit that powered their air-driven tools was called Madeline by the whole platoon. Madeline broke concrete, dug ditches and other excavations, tamped backfill, drove rivets, supplied air to forges, and cut apart rivets that held wrecked bridge members together. One of the biggest jobs was that of dismantling and moving for reassembly elsewhere a 212-foot 2-span through-truss bridge that the Germans had battered badly but not damaged beyond repair. Under a blazing sun, and with dust and sandstorms to harass them, the men worked two 8-hour shifts, but Madeline toiled the full sixteen hours. Then she moved on to Tunisia, where the final victory was won. When last heard from she was in Sicily and still going strong. No matter where she goes now, she will always be Madeline from North Africa to her crew.

* * *

Adams Tunnel Addenda

In our July article on the holing through of the Alva B. Adams Tunnel in Colorado, we quoted the U. S. Bureau of Reclamation engineers as confident, pending a check-up, that the two sections would be found to coincide within an allowable error of 3 inches. Since then it has been discovered that the closure is within $\frac{7}{16}$ inch of perfect on line, and within $\frac{3}{4}$ inch on grade.

Final figures show that 1,800,000 man-hours of labor went into the driving of the 13-mile bore, and that approximately 310,000 cubic yards of rock, measured in place, was excavated. This entailed the drilling of 2,535,000 linear feet (480 miles) of blast holes, an average of 8.18 feet per cubic yard. The holes were loaded with a total of 2,480,000 pounds (1240 tons) of dynamite, the consumption averaging 8 pounds per cubic yard.

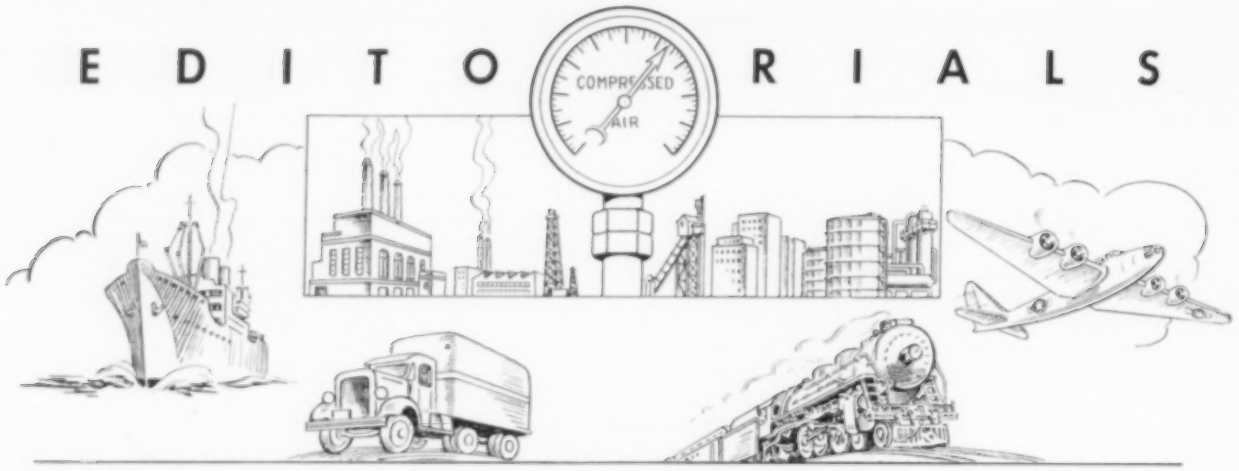
The S.S. Magoffin forces, working from the East Portal, put in 37 $\frac{1}{2}$ months and averaged 1144 feet of advance per month. On the west end, where tunneling was divided between two contractors, work was conducted 31 months and the monthly advance was 833 feet. The western crews drove downhill, with attendant disadvantages, and there were also several months when labor shortages held the work down to one shift daily. The average monthly advance from both ends was approximately 2000 feet.

* * *

Robot Life Rafts

A device that automatically releases life rafts from a sinking ship in case there is not time to set them free by hand is one of the latest mechanical contributions to the Allied war effort. Another aid to survivors adrift is a 4x6-foot sheet of fabric for Carley floats. It can be used variously as a sail, shelter from the sun, or for the collection of rain water for drinking. It is camouflaged on one side and signal-bright on the other, and can thus either conceal a craft from enemy eyes or attract the attention of rescuers.

EDITORIALS



THE TREND OF POWER

THE era that has been loosely referred to as the machine age began during the American Revolution when Watt invented the steam engine. It gained momentum a little more than a century ago when Oersted discovered the magnetic force of moving electricity and Faraday followed with his revelations concerning electromagnetic induction. The steam engine and the electric motor largely supplanted the muscles of man and beast and, for the first time, permitted human workers to have leisure for the development of what we call our modern civilization. That the power epoch brought with it ramified problems is neither here nor there.

A little more than 50 years ago the internal-combustion engine appeared upon the horizon. As the prime mover of the automobile, it gave man a toy with which to play during the leisure hours which the steam engine and the electric motor had bequeathed to him. But its exclusive application to pleasurable pursuits was transitory. It was soon found that it could be harnessed for useful purposes such as driving trucks to haul goods. The steam engine and the electric motor had done little for the farmer. Most of his horsepower still ate oats, and his day was from dawn until dark. The internal-combustion engine freed him from all-consuming labor, just as the earlier forms of power had freed industrial workers. Tractors and other types of farming machinery liberated equine workers. Meanwhile, electric generation and transmission were giving housewives electric light, vacuum cleaners, mechanical refrigerators, and other labor-saving articles, and they, too, found surcease from incessant toil.

Now, though half a century ago there were just four automotive engines totaling less than 15 hp.. we have come to witness the domination of the power world by the internal-combustion prime mover. Most of the machines of war run on gasoline or diesel fuel. As of last March, our own automotive industry alone has built 220,000 aircraft engines, representing nearly 300 million man-made horsepower. They can develop the power of 84 Boulder Dams or 56 Grand Coulee Dams. Recently, the Buick Division of General Motors Corporation announced the production of its 50,000th Liberator Bomber engine, bringing its total aircraft horsepower manufactured in 30 months to 60 million. These are truly stupendous figures. Equally impressive is the statement that each of our infantry divisions has 400,000 hp. of equipment at its disposal, an increase of 11,000 percent over 3200-hp., the figure for World War I.

TUNNELS AID MINING

IN YEARS to come, the present period may be known in Colorado mining annals as the era of tunneling. Although the vagaries of metal prices can set the plans of men at naught, the Centennial State seems to be headed for a revival in mining and, should it develop, it will be attributable in large part to the driving of galleries that lower the cost of ore extraction. The third such tunnel is now underway, and others are being talked about. The Golden Cycle Corporation started the movement when it put up a million dollars to pierce the Cripple Creek ore-bearing zone at a level low enough to drain the water from even the deepest mines and to permit the latter to be carried several hundred feet deeper without having to start up their pumps. Cripple Creek is dormant now because of the ban on gold mining, but the Carlton Tunnel is keeping the workings free of water and saving untold thousands of dollars that, but for it, would ultimately have had to be spent in dewatering the mines. Barring a reversal of mankind's traditional appraisal of gold, Cripple Creek will come back after the war, thanks to the Carlton Tunnel.

The successful construction of the Cripple Creek bore was probably the inspiration for the scheme to extend the Treasury Tunnel under the Black Bear Mine and other properties in the San Juan area. In this instance, it was not alone water but also the numerous disadvantages and hazards of high-altitude mining that economically justified a tunnel. Because it would develop sizable quantities of war-useful base metals, the Government financed the bore. It has apparently done all that its sponsors claimed it would do. Mining operations are being conducted through it and can be carried on the year round at favorable costs and with freedom from snowslides and other former impeding factors. Since the tunnel was excavated, it has been bruited about that private interests are seriously thinking of driving additional tunnels in other parts of the San Juan district. Names of men high up in the affairs of mining are mentioned in connection with these plans, and it is no secret that some of them have been in the section concerned in recent months, ostensibly inquiring into the situation and incidentally negotiating for some of the old mining properties that are known to contain much mineral but can at present be worked only through high-altitude shafts and that must depend upon aerial tramways for transportation of ore, supplies, and men.

The Leadville Drainage Tunnel is the most recent of the mining bores. It is designed to unwater old workings that have not been entered, in some cases, for more than a score of years. As in the San Juan area, there is no doubt about the existence of ore, and Federal funds were advanced to drive the tunnel, which will facilitate the extraction of large amounts of lead and zinc. This project will be described in detail in a future issue.

Combined, the three districts in which the tunnels in question are located have produced around a billion dollars in mineral wealth. Yet the three bores that promise to prolong their lives substantially represent a total expenditure of only about four million dollars, or four-tenths of one percent of the past output. Obviously, the gamble is a small one, considering the possibilities of future profits.

Lawrence B. Abrams

LAWRENCE B. ABRAMS, who was known to many users of compressed-air equipment in the United States, died on June 30 in the Orange (N.J.) Memorial Hospital, following an illness of four months. Since 1934, Mr. Abrams had been general sales manager of Ingersoll-Rand Company, whose employ he entered 32 years ago upon being graduated from the University of Michigan. His father, the late H. T. Abrams, who died in 1941, served the same company before him.

Mr. Abrams was born in West Orange, N.J., June 4, 1890. After a period of training in the Ingersoll-Rand shops at Phillipsburg, N.J., he began his business career as a salesman for the concern in the Cleveland territory in 1913. Service in Washington, New York, and Boston followed, and in 1928 he became manager of the company's Boston office. He was transferred to New York in 1933 as assistant general sales manager, and was made general sales manager the following year.

He was a member of the Delta Tau Delta college fraternity, American Society of Military Engineers, American Society of Naval Engineers, American Society of Mechanical Engineers, Chamber of Commerce of New York City, Metropolitan Opera Club of New York, Corinthian Yacht Club of Marblehead, Mass., Downtown Athletic Club, New York, and the Jockey Hollow Hunt Club of Mendham, N.J. He was also a

LAWRENCE B. ABRAMS

trustee of the First Presbyterian Church of Orange.

During recent years Mr. Abrams lived in Glen Ridge, N.J., and had a farm at nearby Mendham. He is survived by his widow, Mrs. Ida Graulich Abrams; a son, Lieut. (j.g.) Lawrence B. Abrams, Jr., of the U. S. Navy; a daughter, Mrs. Karl Knorr; two sisters, Mrs. Stephen H. Painter and Mrs. Walton Arrowsmith; and three brothers, Thomas, Staats, and Herbert. Funeral services were held July 3 at East Orange, N. J.

Mobile Bins Solve Storage Problem

MOBILE bins are a feature of the Boulder Tungsten Company in Colorado which does custom milling of tungsten ores and has the contract to crush, weigh, and sample ores purchased locally by the Metals Reserve Company. Sometimes as many as 250 separate lots, ranging from 2 to 25 tons each, are received at the plant in a single day. Priorities made it impossible to construct the customary bins and conveyors and resulted in the conversion of gondola cars for storage purposes. Six of these were purchased from the abandoned Denver-Central City narrow-gauge line of the Colorado & Southern Railroad and, complete with understructures, were each transported to the mill site, a distance of 60 miles, on a truck and semi-trailer on which rails had been laid.

Each gondola was partitioned into three bins and heightened an additional 3 feet to give it a total capacity of approximately 45 tons. To facilitate unloading, the bottom of every section was provided with a built-in hopper of planking that converged upon a 2-foot-square cleat gate in one side of the bin. These units travel on 400 feet of track that extends from three ramps, where incoming trucks are unloaded, to the receiving side of the crusher building.

Four cars are normally used at a time and are moved back and forth by an Allis-Chalmers 45-hp., gasoline caterpillar tractor. From the bins the ore flows by gravity to the primary crusher, whence it is delivered either to the concentrator or to the stock pile. However, when material arrives that has to be crushed immediately, it is dumped into an 8-ton hopper that is mounted on railroad trucks and interposed between the center ramp and the crusher. In this way the regular run of ore can be received at the same time at the two other ramps and dumped into the four gondolas, then stationed in pairs on each side of the mobile hopper. When that is the case, half of the bins are pulled directly by the gasoline tractor and the other half indirectly through cables and pulleys, thus obviating the need of moving the tractor from one side to the other to spot cars. This unique storage system is said to be an effective substitute for stationary bins and conveyors where many small lots have to be handled

Belts Spliced in Place

OLD belt-driven machine tools that have of necessity been pressed into war service by the Westinghouse Electric & Manufacturing Company are made to give a good account of themselves by improving existing drives in every way possible. One step in this direction is the use of woven cotton belting spliced by a patented process that was conceived by one of the company's beltmen and perfected by engineers of the company. It provides a flat belt drive, calling for no critical materials, and an endless belt for machinery that is not constructed for belts of that kind. The procedure is somewhat like that followed in joining leather belts, and is done right at the machine without the need of special tools and equipment.

Allowing for splice and deduction for stretch, the belt is cut to length. Then the ends are tapered to a featheredge, with each ply being step cut, and are prime coated with a solvent and cement solution. After drying for from 5 to 15 minutes, a sheet of cement that has been immersed in a solvent is placed between the ends and the belt is firmly clamped and permitted to dry, the time depending upon the size of the belt and the room temperature. In the case of a 4-ply belt 2 inches wide, the clamps can be removed in fifteen minutes; but the belt should remain idle about twenty minutes longer for thorough drying. This interval can be reduced, especially where critical machine tools are involved, by carrying in stock belts of the required length with the ends tapered ready for splicing. Should a belt become loose, it can be made to fit by cutting and resplicing it. Furthermore, when equipment has to be shifted, belts can be easily taken off and put back in place.

Westinghouse is using cotton belting of this type with sensitive drill presses, multiple-spindle drill presses, profilers, screw machines, grinders, as well as for other types of drive such as heavy-duty air compressors and belt conveyors. They are from 2 to 8 plies in thickness, range in width from $\frac{3}{8}$ inch to 84 inches, and are of any desired length. The company employs an "inner-bound" belt woven to its own specifications because the average woven belt does not have the tensile strength required for power-transmission purposes and is not of the proper construction to permit splicing. The special weave makes for high flexibility and prevents the plies from separating should the surface threads become worn or break.

It is the company's experience that woven cotton belting cemented together as described not only costs less than other belting but increases production through reduced slippage and shutdowns due to breakage.

Industrial Notes

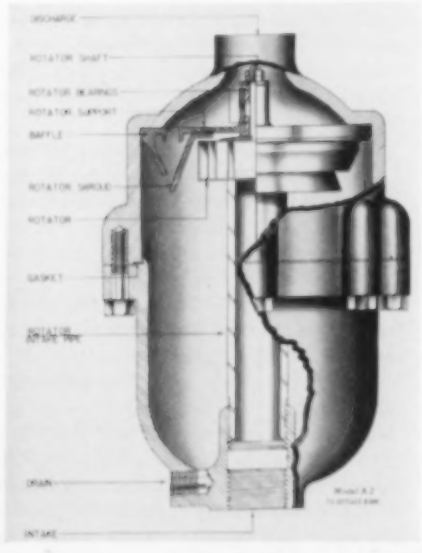
Spent paper-mill sulphite liquor that was allowed to go to waste until fairly recently is now the source of as many as 79 useful chemicals.

Mixed with water and applied as a paste, Fix-iron is said to seal cracks in iron, steel, brass, and wood, to stop leaks at joints, to fill castings, etc. It comes in powder form in 1 to 100-pound containers.

To prevent overspray from fouling booth sheets, nozzles, and circulating lines in water-curtain-type paint-spray booths, Penetone Company recommends its Traversite. It is a powder that, after an initial application of 1½-3 pounds per 500 gallons of water, is added at the rate of 1 pound at 8-hour intervals.

Under the designation Safeco 556, the Swan-Finch Oil Corporation is offering an improved sulphurized oil that combines cutting and lubricating properties. It is intended for screw machines in which cutting and lubricating oils tend to mix. It does not stain steel or nonferrous metals, it is claimed.

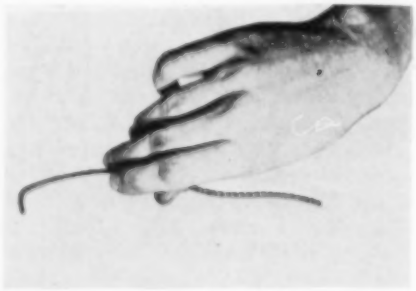
A new unit for removing moisture, oil, scale, and other foreign matter from compressed air has been announced by the Bird-White Company. Known as the Turbo-Rotor Pur-O-Fier, it operates on the centrifugal principle. The air enters the unit at the bottom, as the accompanying illustration shows, and rotates a noncushioning, perfectly balanced, high-speed rotor. The latter beats the atomized moisture and vaporized oil into larger particles, which are driven outward and downward by a shroud and drained by gravity into a reservoir designed either for manual or automatic discharge. Three models are available for volumes of ½ to 5 cfm., 10 to 35 cfm., and 35 to 100 cfm. For anything beyond that range, units can be mounted in multiple to meet any needs for regular or intermittent service. Where more than one compressor is installed and the amount of compressed air used fluctuates, each Pur-O-Fier in the system can be provided with a valve for volume control.



More than 200 rubber items enter into the construction of a Boeing B-29, Uncle Sam's new superbomber, according to engineers of the United States Rubber Company. They weigh close to 5000 pounds, of which nearly 4000 is required to make the 30 bullet-sealing fuel tanks. The six tires and tubes contain less than 600 pounds, leaving only 400 for hose, shock pads, upholstery, and the long list of other uses.

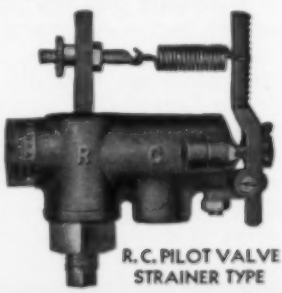
Users of packing for hydraulic and pneumatic equipment will be interested in the revised edition of E. F. Houghton & Company's *Handbook on Hydraulic & Pneumatic Leather Packings*. It contains fourteen informative chapters that cover every phase of the subject from the kinds of packing and their application to the design and support of packings, lubrication, troubles encountered through improper installation, and storage and care of leather packings. Chapter fourteen consists mostly of price lists and tables giving, among other figures, capacities of hydraulic rams in tons, gallons in round cylinders for one foot of depth, and safe loads for U. S. standard bolts. The textbook is profusely illustrated and handsomely bound in a stiff cover. It is available for general distribution to industrialists writing E. F. Houghton & Company, 303 West Lehigh Avenue, Philadelphia, Pa., on their own letterheads.

Shopmen who have used the conventional spiral-wound abrasive strip for finishing and polishing oil holes in places hard to get at, may be interested in an improved abrasive of this type that is said to hold its shape. It is made by the Minnesota Mining & Manufacturing Company of Elek-Tro-Cut Three-M-Ite cloth wound around a reinforcing that permits it to be bent, as the accompanying picture shows, so as to reach down through a center and to thread it through an opening that normally presents a finishing problem. The product is available in a wide range of grits, in lengths up to 12 inches, and from 1/16 to ¼ inch in diameter.



For use either as a permanent or portable installation, Garlinghouse Brothers has announced a self-contained cable-splicing rig that can be set up ready

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



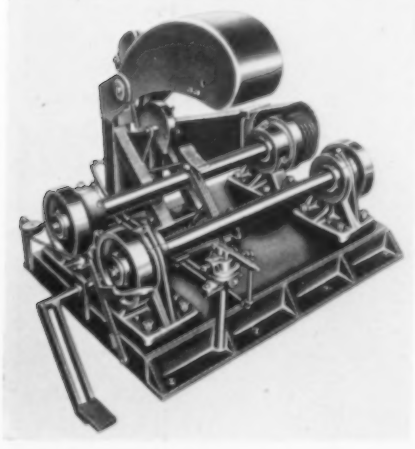
R. C. PILOT VALVE
STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET · ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

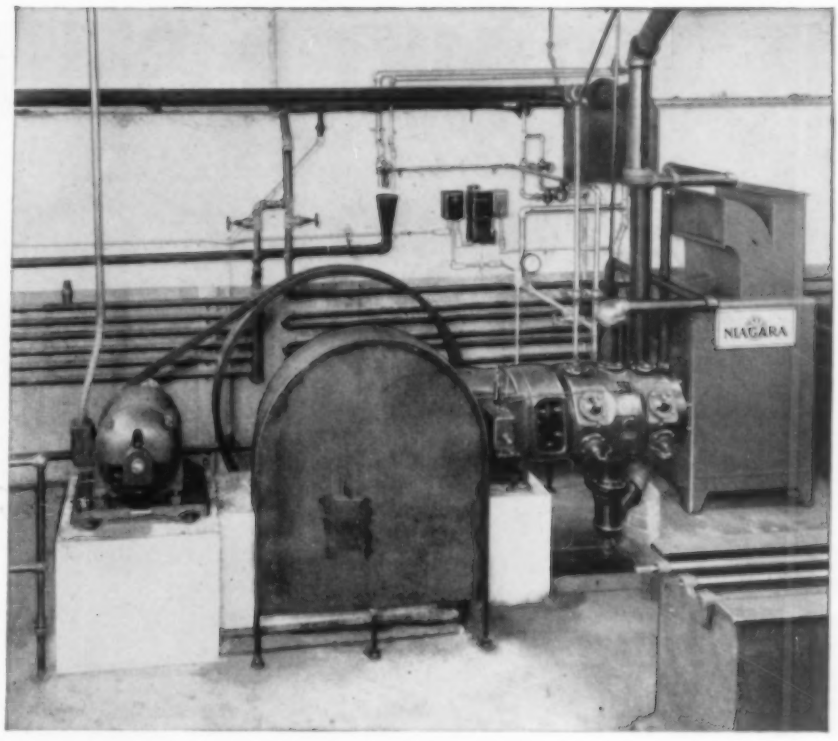
for work in ten minutes, it is claimed. It may be mounted horizontally or attached vertically to a column, post, or tree; and for compactness and ease of handling has detachable top and bottom members. In place, the unit has an over-all size of 96x45 inches, and it weighs about 250 pounds.

It is reported that the life of melting pots for magnesium and aluminum, of core boxes, loading racks and fixtures for heat-treating operations, etc., can be lengthened by means of a refractory applied by a flame-coating process developed by the Neo-Mold Company. The latter does the work in its own plant and claims that a melting pot that normally handles from 25 to 30 heats will be good for from 50 to 60 when protected against scaling and breakdown by the new process.

Centrifugal casting machines are finding increasing application because of the high pressure with which the metal is cast in the mold. One of the newest is a horizontal machine that is especially suitable for making bushings or other cylindrical parts. The unit is built by The Centrifugal Casting Machine Company and is known as the Model M. It is designed to take either a metal mold or a flask for sand molding, which is supported on the wheels of a motor-driven shaft and of a paralleling idler shaft and kept in position by a pneumatic hold-down.



This consists of a wheel and housing which is hinged to the casting machine to facilitate mold-changing. Air, preferably at 80 pounds pressure, is used to operate the hold-down; but should the air supply fail, a safety device automatically locks the mold in place. An adjustable control provides variable speed of rotation which is stopped by a foot brake, and a tachometer gives reading of the speed for any set-up. The Model M is available in six sizes for the production of both ferrous and nonferrous castings ranging in length from 10 to 48 inches and in outside diameter from 1½ to 16 inches.



PROTECT YOUR AIR TOOLS

● The moisture that is condensed from compressed air is the chief source of trouble with air lines, tools and equipment. It may freeze in the lines; it may rust or damage products exposed to the air stream; it washes the lubricants out of your tools and causes rusting and more rapid wearing out of parts, especially in rotary tools.

To protect this equipment, take the excess moisture out of compressed air by using the NIAGARA *AERO* AFTER-COOLER. It produces lower compressed air temperatures and the resulting air contains only one-half to three-fourths as much moisture as air cooled by conventional methods. Because it is an evaporative cooler, it uses atmospheric air as the cooling medium and pays for itself by saving water costs.

For Complete Information, write to

NIAGARA BLOWER COMPANY

"25 Years of Service in Air Engineering"

NEW YORK Address: Dept. CA 84
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Field Engineering Offices
in Principal Cities

NIAGARA

INDUSTRIAL COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

MANPOWER SHORTAGE?

Lead us to it!

WE pity the salesman (if there ever was one) who went to California in 1849 with a scheme for relieving the manpower shortage. There wasn't any! And as for detachable bits, all anybody wanted was to get first crack at a claim with a pick and shovel.

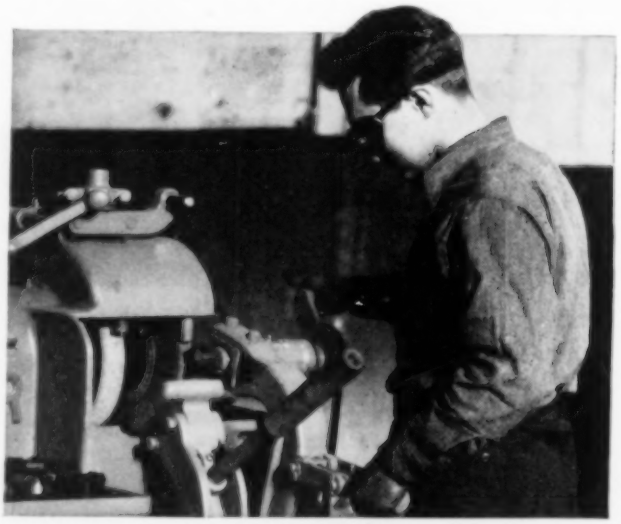
But today, detachable bits help to relieve critical manpower shortages wherever men drill. They save steel shop costs and nipping charges, and drill faster than ordinary bits even in soft or muddy ground. More important, they save time and labor, because you don't have to carry steel in and out of working areas.

But the most efficient, time-saving feature of detachable bits is their grinding. A simple forming and gauging operation is all that's needed to keep them in good working condition. But it's necessary to use the *right* grinding wheel—for example, an "Aloxite" Wheel by Carborundum that cuts free and cool, and preserves the temper of the steel. Production is speeded up, and drilling costs reduced when you keep your drills properly ground with Grinding Wheels by Carborundum.

The Carborundum Company
Niagara Falls, N. Y.

CARBORUNDUM
ABRASIVE PRODUCTS

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Buffalo, Pittsburgh, Cincinnati, St. Louis, Grand Rapids



Grinding Wheels by CARBORUNDUM
TRADE MARK

(Carborundum and Aloxite are registered trade marks of and indicate manufacture by The Carborundum Company)

Rubber fingers that pick up bags of sugar

A typical example of B. F. Goodrich development in rubber

GETTING hundred pound sacks of sugar up a grade that looks like this ◿ was causing plenty of trouble in a Louisiana sugar mill. The bags could be trucked to within a few feet of the Mississippi river. But they had to be conveyed across a high levee to get to the wharf. The bags simply slipped off regular smooth-surfaced conveyor belts. Then wire mesh belts and belts with cleats across them were tried. But both the wire and the ridges tore the bags and spilled good sugar on the river bank. It looked as though the only remedy was to lengthen the conveyor to reduce the steepness of the slope — a costly and inefficient way of handling sugar.

Then B. F. Goodrich learned of the problem and suggested a belt of theirs made with 3000 tiny flexible "fingers" per square foot. This B. F. Goodrich development was originally designed to carry cartons up and down inclines in food plants. But it proved to be the answer for the sugar bags, gripping them firmly but gently. Tearing of bags became a thing of the past. That was five years ago and the original belt is still in service down on the levee.

B. F. Goodrich men often find that a product developed for one purpose will solve an entirely different problem. That's why they suggest you consult a B. F. Goodrich distributor or write the B. F. Goodrich Co. if you have a problem that might be solved with rubber — natural or synthetic. *The B. F. Goodrich Company, Industrial Products Division, Akron, O.*

B.F. Goodrich

RUBBER *and* SYNTHETIC *products*

Bearings that EXTEND PUMP LIFE

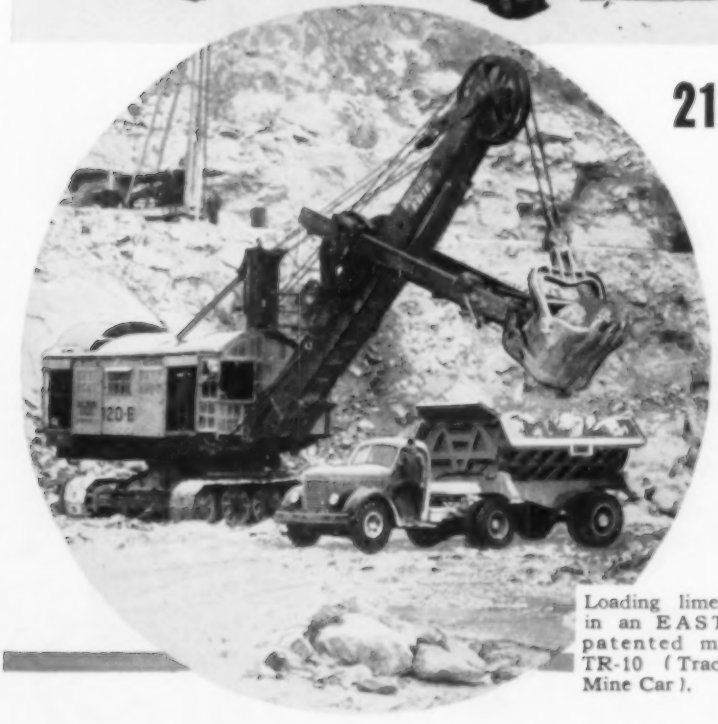
SKF
Puts the Right Bearing in the Right Place
DEEP-GROOVE BEARINGS
Single row with deep, uninterrupted raceways permitting radial and thrust loads in either direction. Groove curvature conforms closely to balls, resulting in large contact areas.
One or more of these types are used here—
CYLINDRICAL ROLLER BEARINGS
A single row of cylindrical rollers guided by flanges. Long contact surfaces between rollers and races. Also made with two rows of staggered ultra-precision rollers.
SELF-ALIGNING BALL BEARINGS
Self-contained. Their inherent property of alignment insures full capacity while compensating for any inaccuracies due to initial misalignment, shaft deflections, distortions or weave.
SPHERICAL ROLLER BEARINGS
Also self contained. Completely self-aligning for extra heavy radial and thrust loads or for severe shock conditions. Barrel-shaped rollers in a uniform path assure positive roller guidance.
These bearings never need adjustments . . . require only minimum lubrication.
SKF
Ball and Roller BEARINGS

The bearing situation is well in hand on this 750 h.p. Cameron Centrifugal Pump. Carrying radial loads only, an SKF Self-Aligning Ball Bearing mounted in a dirt-and-grease tight housing is free to move to take care of difference in expansion and contraction between the pump shaft and casing. On the outboard end, a fixed SKF Duplex Angular Contact Ball Bearing takes the thrust load. For bearings that require only infrequent lubrication, that have negligible wear, that assure accurate alignment at high speeds, pump manufacturers specify SKF's.

5615

SKF INDUSTRIES, INC., PHILA. 34, PA.

● *Built by* INGERSOLL-RAND CO.



Loading limestone in an EASTON patented model TR-10 (Trackless Mine Car).

213,800 MAN-HOURS without *Accident!*

MODERN methods and equipment are essential to every safety program. EASTON semi-trailers and equipment play a big part in the accident free production of limestone at this quarry.

EASTON engineers are quarry-haulage specialists. Write to: Engineering Counsel, Easton Car & Construction Company, Easton, Pa.

EASTON

INDUSTRIAL CARS
TRUCK BODIES · TRAILERS
ELECTRIC LIFT TRUCKS

B-1011

3 reasons for selecting

BETHLEHEM SUPERIOR HOLLOW DRILL STEEL

In making Bethlehem Superior, melts are held to the most exacting chemical and metallurgical specifications. Carbon range lies between 0.75 and 0.85.

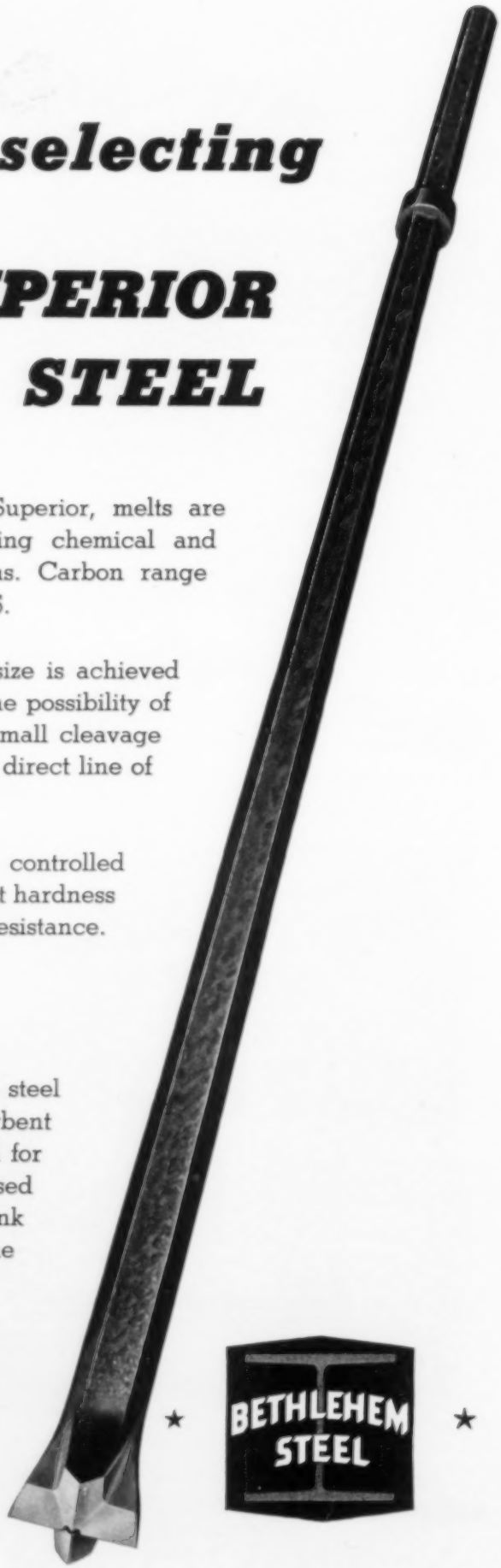
A proper balance of grain size is achieved throughout. This eliminates the possibility of too many large or too many small cleavage planes. As a result, there is no direct line of cleavage to encourage failures.

Rolling temperatures are rigidly controlled from start to finish, assuring correct hardness for maximum shock- and fatigue-resistance.

★ ★ ★ ★

In Bethlehem Superior, you get a drill steel that is tough, resilient, and shock-absorbent . . . a fatigue-resisting steel that is ideal for both forged-on bits and fabricated rods used with detachable bits . . . a steel whose shank end withstands the punishing blows of the drill piston.

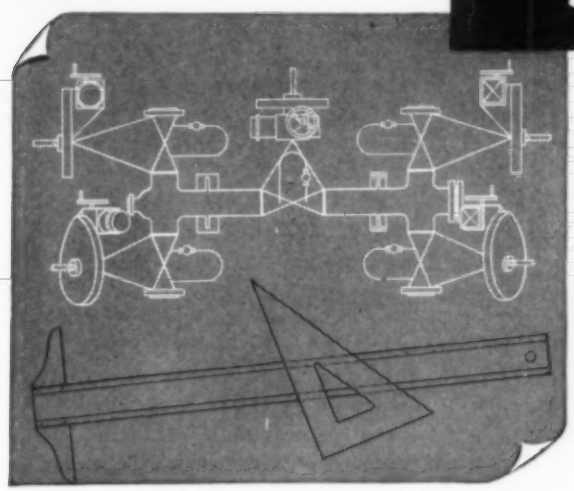
It's an old favorite with mining men, quarry men, and contractors. Next time you order hollow drill steel, specify Bethlehem Superior.



★ BETHLEHEM STEEL ★

Shop-Fabricated Assemblies . . A Complete Service from CRANE

1. ON THE DRAWING BOARD — *No matter how complex your piping assembly design may be, all parts—valves, fittings, and pipe—are supplied by Crane. One source of supply—one order covers everything.*



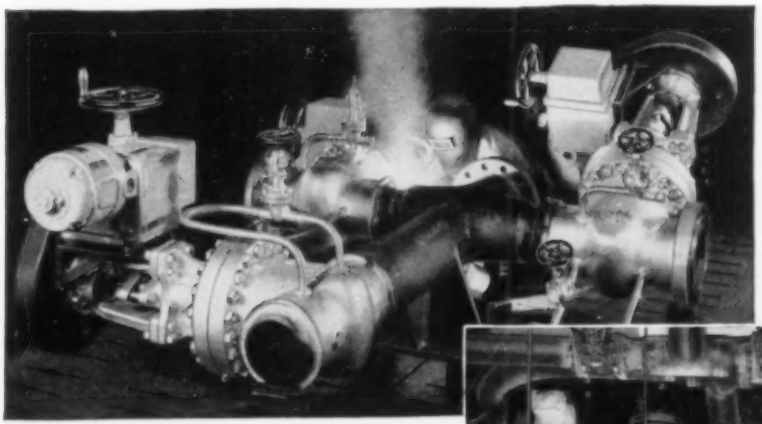
SHOP-FABRICATION typifies Crane complete service in the highest degree. Your blueprint in Crane Pipe Shops means delivery to your installation of a unit meeting every intent of design. For at Crane, no job is too small—none too large or complex—and absolute adherence to specifications is a matter of pride.

As the world's leading supplier of valves, fittings, and fabricated piping, Crane Co. produces all types of header assemblies of valves and fittings. Completely shop-welded, stress-relieved and tested, and conforming fully to code requirements, such Crane-built units—whether for power or processing systems, high or low pressure—stand out as the finest combinations of materials and workmanship.

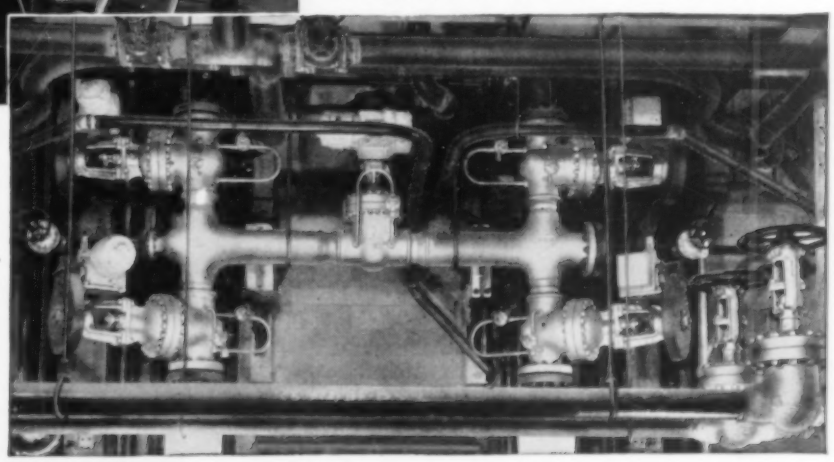
The same rigid control applied in making Crane valves and fittings marks every pipe shop operation. From raw materials to finished assemblies, one high standard of quality is maintained by the most elaborate facilities in the industry. Your complete satisfaction with every job is assured by Crane Co.'s 89-year leadership in the piping equipment field.

Crane Co., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*

2. IN THE FABRICATING SHOP — *All designs are completely fabricated by Crane. Proper selection of all parts is assured by the complete Crane line. One responsibility covers all materials and workmanship.*

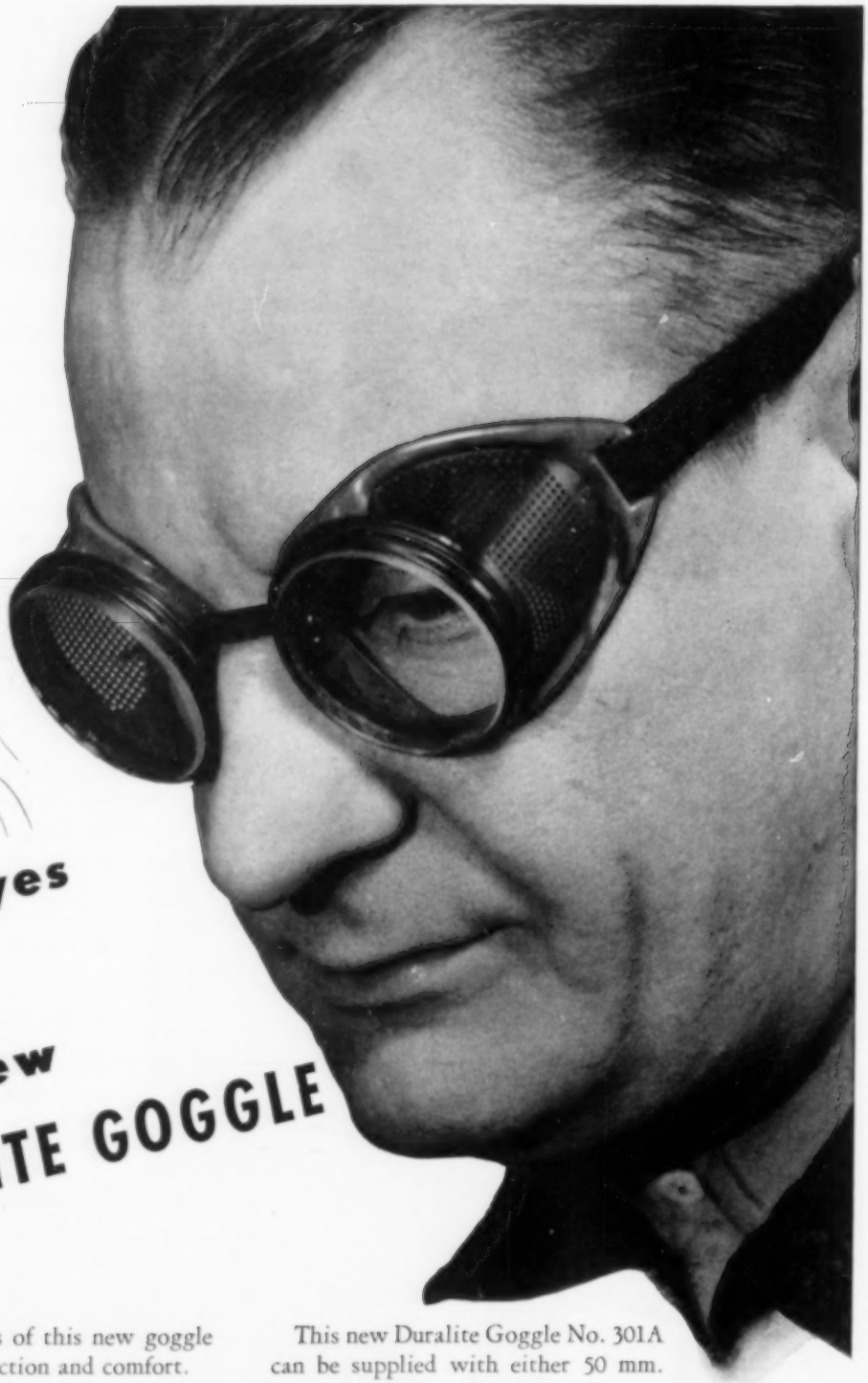


3. ON THE JOB—*With Crane materials and Crane craftsmanship in every part, one standard of quality guards the entire assembly. Shown is the completed 12 x 8 x 4 in. header assembly of 600-pound cast steel motor-operated gate valves and fittings, installed in a central station.*



CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS



Keep their Eyes On The Job with the New AO DURALITE GOGGLE

Specifically, here are the features of this new goggle that add up to all-around eye protection and comfort.

Larger side shields have perforations nearly double in size and number. This increased ventilation produces a natural draft that keeps lenses clear and eyes cool. Two other AO advantages: new curved nosepiece assures a more comfortable fit; all-elastic headband holds goggles firmly in place.

And the new lightweight acetate eyecups, with smooth, rounded edges, are individually shaped to fit the left and right eye snugly. This closer, more comfortable fit guards against particles striking from all angles, while impact-resisting Super Armorplate lenses protect against direct hits.

This new Duralite Goggle No. 301A can be supplied with either 50 mm. Super Armorplate lenses in clear or Calobar shades. Order from your nearest AO Representative . . . today.

P. S. For the worker who must wear spectacles and needs protection for short periods, the AO Duralite Coverglas Goggle—with the same safety and comfort features as the standard Duralite Goggle—is recommended.

American Optical
COMPANY
SOUTHBRIDGE, MASSACHUSETTS

MANUFACTURERS FOR MORE THAN 111 YEARS OF PRODUCTS TO AID AND PROTECT VISION. BRANCHES IN ALL PRINCIPAL INDUSTRIAL CENTERS

—PROTECT YOUR EQUIPMENT AT BOTH ENDS OF YOUR LINE

Air tool or air compressor—there's a Shell Lubricant "custom-refined" to fit both types of equipment.

Shell Compressa Oil, for air compressors, and Shell Clava Oil, for air tools, both contain the specific characteristics to match the job for which it is to be used. For only when the lubricant *matches* the job are you sure of a thoroughly reliable performance.

Send today for details on Shell's "Custom-Refined" Lubricants for compressed air use.

SHELL **COMPRESSED AIR LUBRICANTS**

COMPRESSA OIL
FOR AIR COMPRESSORS

CLAVA OIL
FOR AIR TOOLS

Worn or Broken Surfaces can be BUILT UP *quickly* with "997" Low-Fuming Rod

Let's help the other fellow, too.

Under the stress of present industrial output, mechanical production equipment often feels the strain. Bronze Welding is being used extensively, not only for the repair of iron, steel and copper alloy parts, but also for the building-up of worn surfaces. If you've done an interesting bronze welding job that you feel would help the other fellow, tell us about it. If of general interest, we'll pass the word along in these pages.

With five teeth gone from this large gear and an important production unit stopped dead in its tracks, what's a Production Manager to do? A new gear meant patterns, castings, days of machining—weeks of delay. Pegging the broken teeth would cut down the delay—but increase the hazard of a repeated failure.

It's in a pinch like this that the importance of Bronze Repair Welding with the oxy-acetylene torch is most appreciated—for by using this fast, economical method of repair the gear was welded, machined and back in operation in a few days. Low temperature bronze welding with "997" Low-Fuming, Tobin Bronze* and other Anaconda Welding Rods is so controllable that it is often possible to weld parts without dismantling, and in many instances, finish by filing to a template.

"*Don't Scrap It...Bronze Weld It!*" is more than a slogan—it's a NECESSITY in many plants. Publication B-13 contains suggested welding procedures and examples of savings in repair time and expense. Write for a copy.

*Reg. U. S. Pat. Off.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut • Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA
from mine to consumer

Anaconda Bronze Welding Rods

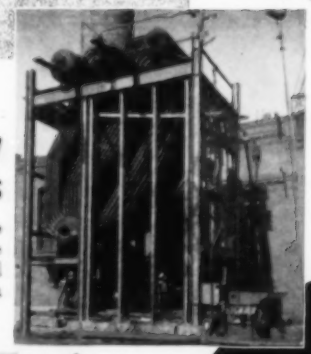
Vogt

PRODUCTS ARE

★ DESIGNED to RAISE
★ OPERATING STANDARDS and
★ LOWER YOUR COSTS

Drop Forged for Safety and Economy under the Most Trying Conditions

Valves, Fittings and Flanges by Vogt—the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.



High Operating Efficiencies and Low Maintenance Costs

More steam per dollar of investment—because Vogt steam generating equipment is designed and built to fit in with specific operating conditions. Vogt boilers are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuels, as desired. Three-drum types can be supplied to fit any conditions of restricted installation space.

Meeting the Demands for Operating Security

Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

Vogt PRODUCTS

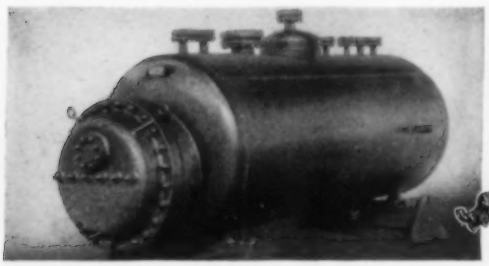
For Oil Refineries, Chemical Plants, Power Plants and Related Industries

☆

HENRY VOGT MACHINE CO.

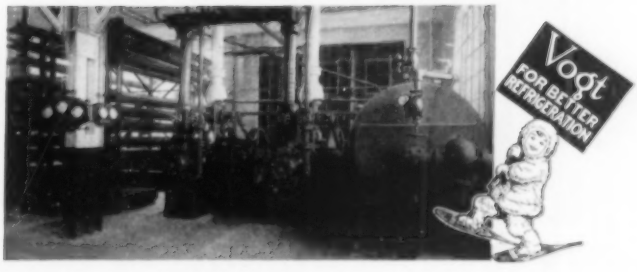
LOUISVILLE, KENTUCKY

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS



To Combat Corrosion and Product Contamination

Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.

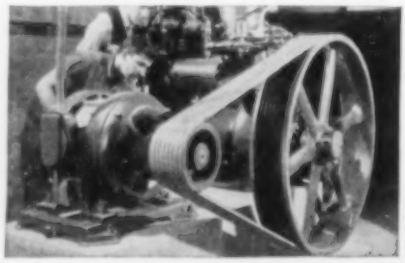


Steps Tonnage Up and Costs Down

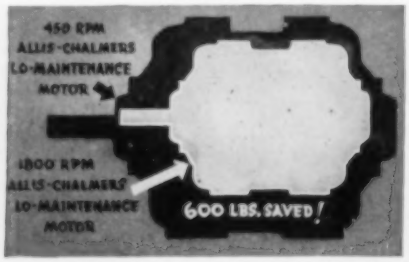
Our experience of more than 50 years in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries, etc.

A-C "Team" Flexibility

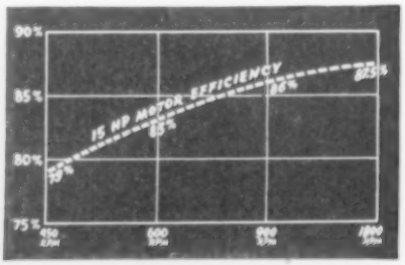
★ To drive low speed machinery with high speed motors (now that low speed motors are sharply restricted), Allis-Chalmers Texrope Drives can "gear down" motor speeds over a range of 7 to 1. As America's only builder of *both* motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper com-



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*



2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY — WE PLAN FOR PEACE

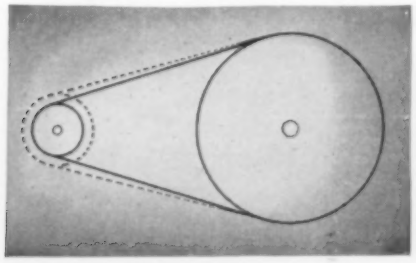
ALLIS-

Gives You now needed

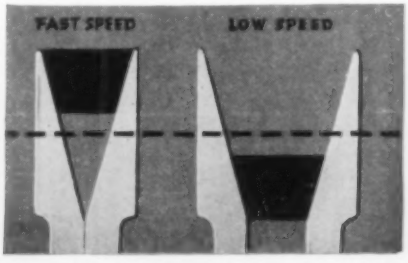
bination . . . today offers you the benefit of long pioneering experience. Texrope Drives are compact, highly efficient, protect your equipment by absorbing shock.

★ To drive a machine at different rates with a single speed motor (now that multi-speed motors are sharply restricted), Texrope Adjustable-Speed Drives give you infinite speed range up to 375%. And in Allis-Chalmers full line of Texrope Drive equipment you'll find the *right* range for your machines . . . thus avoid paying extra for more speed than you need. For engineering cooperation, feel free to call on your nearby Allis-Chalmers district office or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

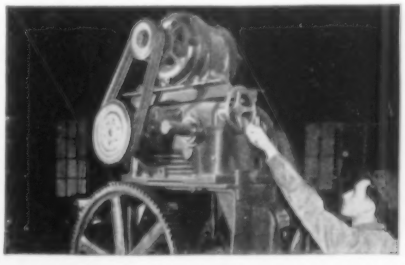
A 1706



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.



5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!

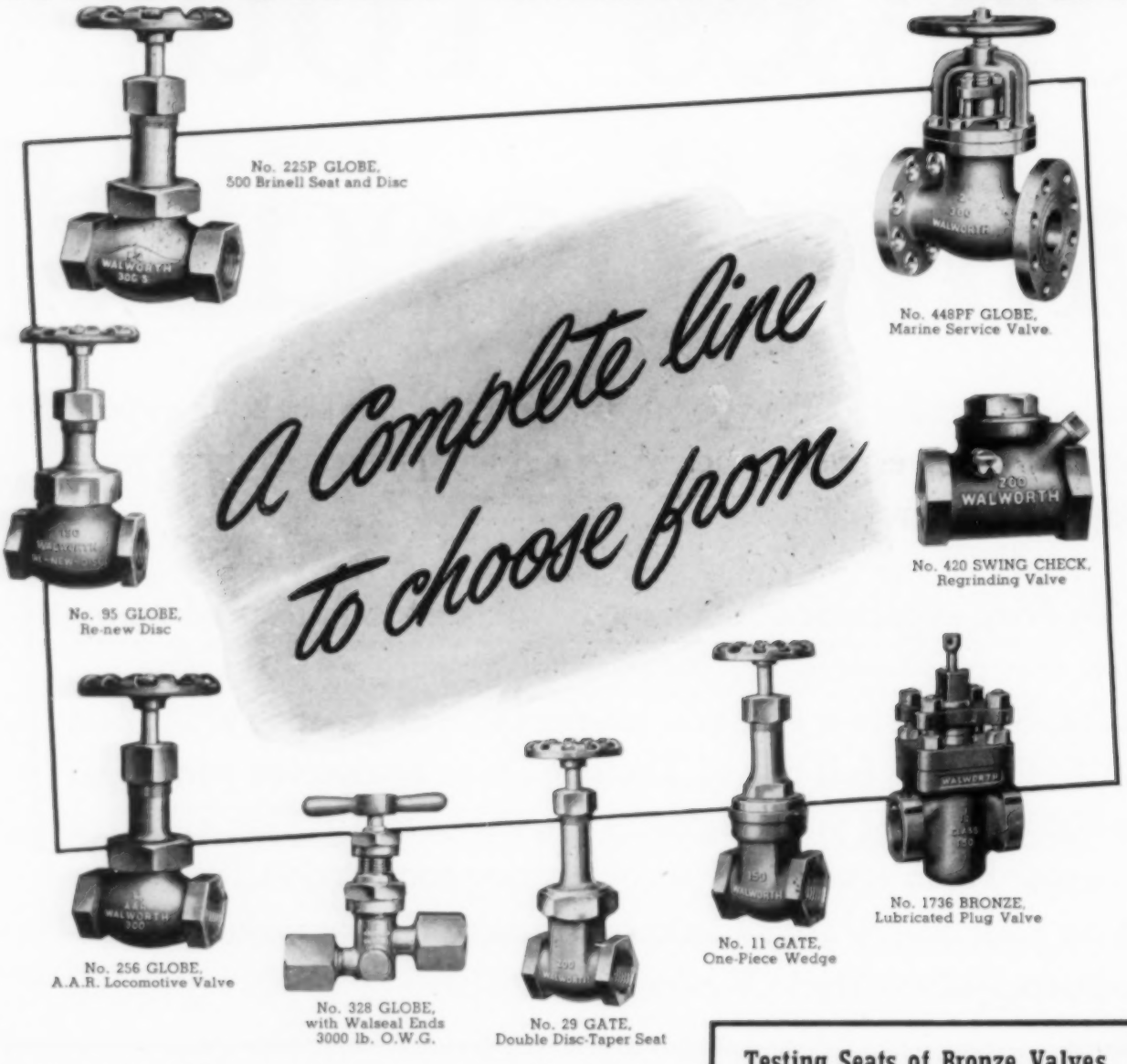


6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES

WALWORTH BRONZE VALVES



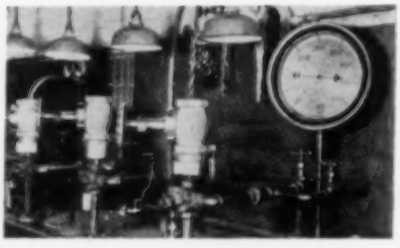
Walworth's *complete line* of bronze valves, a number of which are illustrated above, includes types designed to fit every service where bronze valves are required. Strict laboratory supervision of the physical, chemical, and metallurgical properties of the materials entering into all Walworth products is supplemented by continuous inspection of the manufacturing operations, both as to accuracy and quality of finish, and by rigid final inspection and testing of each individual product.

Walworth manufactures a complete line of valves and fittings in steel and iron, as well as bronze. Cast iron pipe and three types of pipe wrenches are also made. For full details on Walworth products write, on your company letterhead, for a free copy of Walworth Catalog 42.

WALWORTH
valves AND fittings
60 EAST 42nd ST., NEW YORK 17, N. Y.

BOSTON WORKS
KEWANEE WORKS

Testing Seats of Bronze Valves



Assembled bronze valves are subjected to test under pressure—either air-under-water, steam or hydraulic. The hydraulic seat test is shown here. Walworth Quality Bronze Valves undergo a hydrostatic shell test of three times their rated working steam pressures.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Flaps down! Hook down! TIGER BRAND landing ropes up!

"It's no easy job landing on a carrier. It may be an 'airfield that floats' but it isn't the best landing strip in the world. You have only a very short distance in which to land, and stop. *Long swells make the deck roll. You make a wide turn around the stern and head in. The landing officer draws a hand across his throat. Cut! You close the throttle and slap her down. The hook catches a landing rope, your wheels strike, and you are pulled to a stop. You're down!"*

• • •

INDISPENSABLE part of the ingenious arresting gear that gentles a landing plane to a safe stop on a U.S. carrier's flight deck, American TIGER BRAND Wire Rope does its part in carrying our Navy's aerial punch to every far-flung corner of the seven seas.

Made of high-strength steel, the special TIGER BRAND Arresting Gear Rope (Excellay Preformed) was selected for the major share of these installations because it ideally combines the strength, stamina and flexibility vital for safety in this highly hazardous duty.

This application of TIGER BRAND is typical of many wartime uses in which our research and manufacturing departments have collaborated to produce wire rope to meet severe and unusual requirements. It is on the basis of such accomplishment that we can promise you in TIGER BRAND a better product than ever before, when wire rope again becomes fully available for civilian service.

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York

USS

Excellay Preformed

UNITED STATES STEEL

25 Years

of Service to the users of Cook's Packings and Piston Rings

IT has been said a good product attracts able salesmen and capable service men. This may be so, but we, the manufacturer of COOK'S Metallic Packings and Piston Rings, feel we have been unusually fortunate in having our Mid-Continent activities in the hands of W. Woobank. We feel so good about it we are taking this means on the 25th anniversary of his association with us to publicly congratulate him on the excellent job he has done. We believe his host of friends share this feeling also and that they too join us in wishing him continued success and good health.

Starting with an office in Tulsa with activities limited to the state of Oklahoma, Mr. Woobank extended his operations to cover new fields as they developed until today his territory takes in the whole of the Mid Continent with a branch office in Houston.

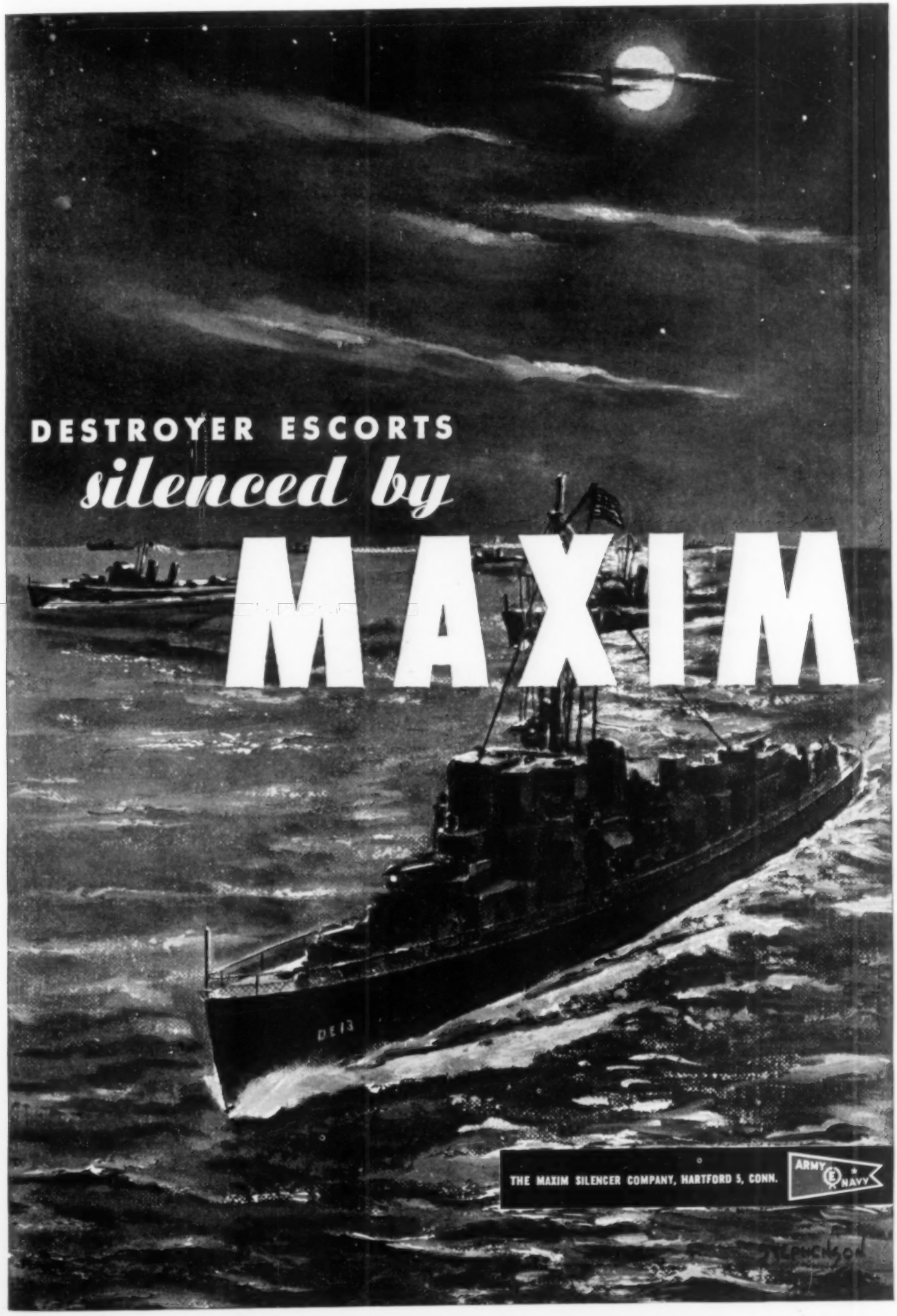
Loyal, friendly, sincere and capable, Mr. Woobank is the kind of man you like to deal with—he is the kind we like to have represent us.

Sealing Pressures — Since 1888

C. LEE COOK MANUFACTURING CO. INCORPORATED

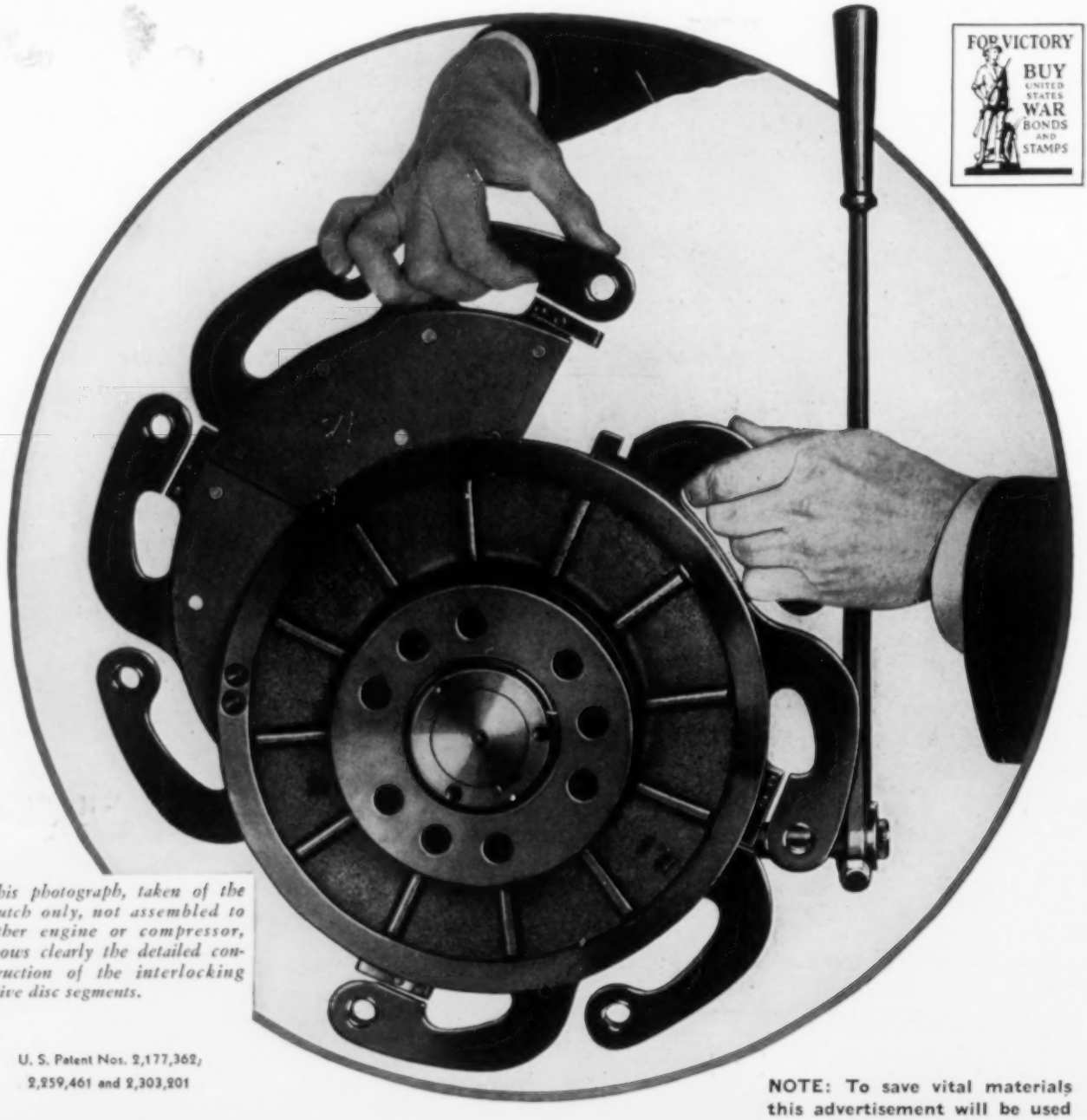
LOUISVILLE, KY.

BALTIMORE • BOSTON • CHICAGO • CLEVELAND • HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS • NEW YORK • SAN FRANCISCO • TULSA


DESTROYER ESCORTS
silenced by
MAXIM
DE13
THE MAXIM SILENCER COMPANY, HARTFORD 5, CONN.
ARMY E NAVY

FLEX-DISC CLUTCHES

Used on the entire line of I-R *Mobil-Air* Compressors, have a time proven drive disc with flexible fingers solidly bolted to the fly wheel. When the friction facings become worn these drive discs, which are quickly detachable in segments, may be removed and relined or replaced without disconnecting the engine from the compressor.



FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

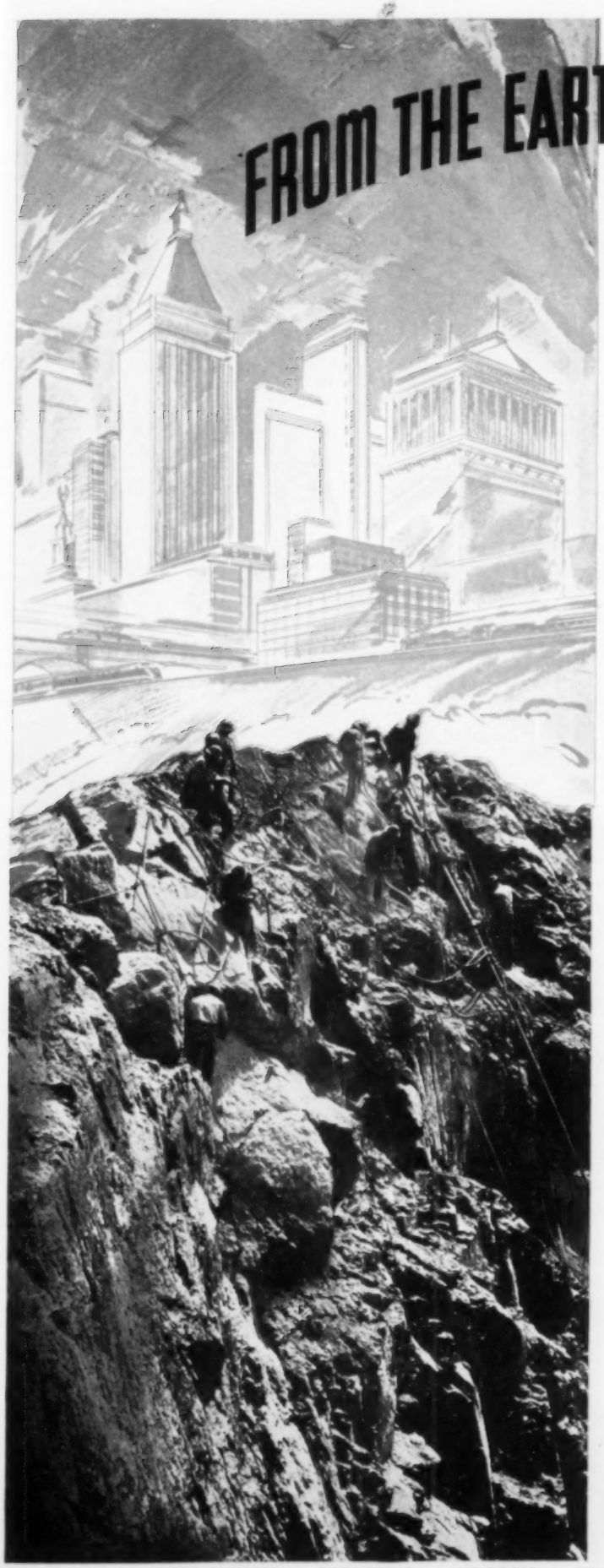
This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362; 2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin



FROM THE EARTH'S ROCKY CRUST A GREATER NATION ARISES

Our nation is built on a very desirable part of this earth's rocky crust. We have improved this crust by recovering and converting its products into the facilities and materials needed to build our progressive type of civilization.

It is honeycombed by our mines and tunnels, carved by our quarries, highways, railroads, canals and pipe lines. On its rocky base rest our skyscrapers, homes, and factories. From it come those materials—solids, liquids, and gases—which we need for all we produce, consume, and use.

Rocky—yes, and this rock is excavated by rock drills driven by compressed air—each drill striking thousands of blows per minute against the steels which cut the holes for blasting.

Here are just a few of the famous American engineering achievements made possible with rock drills: the Grand Coulee, Shasta, and Boulder Dams . . . the Pennsylvania Turnpike and Alcan Highway . . . the TVA Power Project . . . the New York City and the Hetch Hetchy Water Supply Systems . . . the subways and river tunnels in our big cities . . . the Big-Inch and Little-Inch Pipe Lines . . . the thousands of miles of tunnels and shafts in our metal and coal mines . . . the tremendous open-pit mines on the Mesabi, in Bingham, at Ajo and at Morenci.

Ingersoll-Rand rock drilling equipment has contributed greatly to the successful completion of these significant projects. By drilling out and exposing the still hidden potentialities of the earth's rocky crust, even more vital assistance will be rendered in the years to come. This will help create that greater nation which is our destiny.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N.Y.

5-397

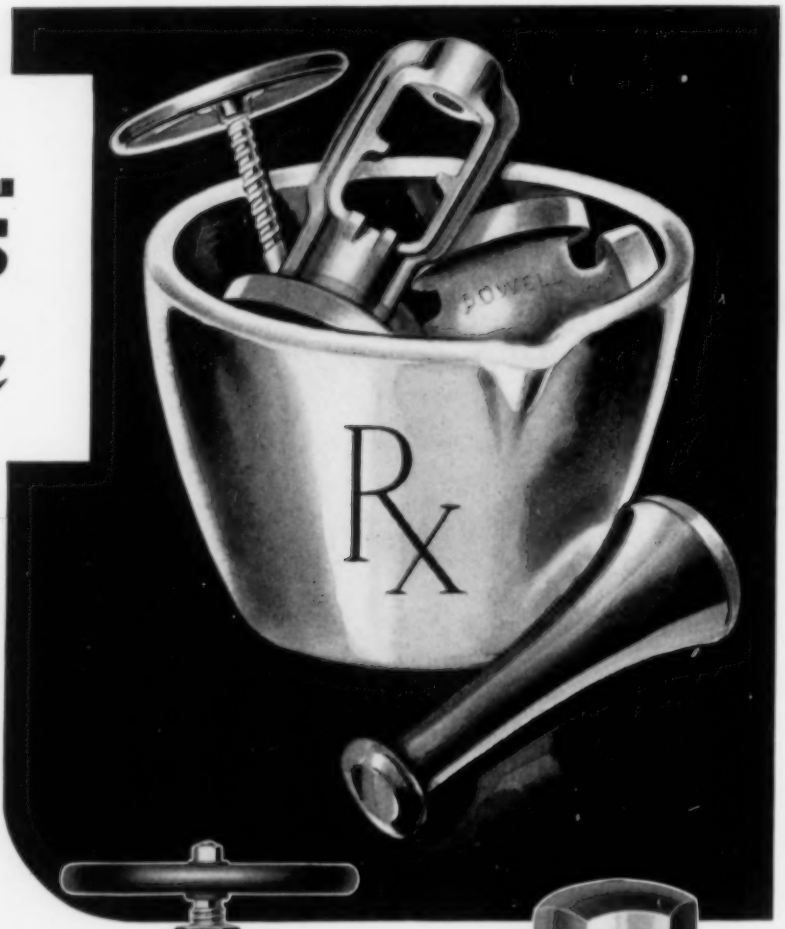
COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

★ ★ ★ ★ ★

★ POWELL VALVES

★ *by prescription*

★



"Doctor-book" treatment is of dangerously doubtful value when an undiagnozed condition exists, or is suspected to exist! The experienced collaboration of physician and pharmacist is not only indicated but required.

Specific conditions to be met in the installation and functioning of valves likewise demand scientific specialization . . . the working-together, understandably, of engineering and manufacturing experience to produce the valve to meet these conditions.

The successful experience of nearly a century of POWELL Engineering and manufacture of valves—and valves only—is at your service . . . in consultation, in prescription, in supply. This clinical know-how, gained in thousands of "cases" is the professional asset we share with every POWELL Valve buyer.

Fig. 301—Iron Body Bronze Mounted Globe Valve for 125 pounds W. S. P. Has flanged ends, outside screw rising stem, bolted flanged bonnet, renewable composition disc and renewable bronze seat ring. Sizes 2" to 10", inclusive.

Fig. 95—Bronze "White Star" Dash-Pot Check Valve designed for air compressor service. Has screwed ends, screwed cap and regrindable, renewable "Powellium" nickel-bronze disc. Because of the cushioning effect of the plunger in the dash-pot, the seating of the disc is practically noiseless.

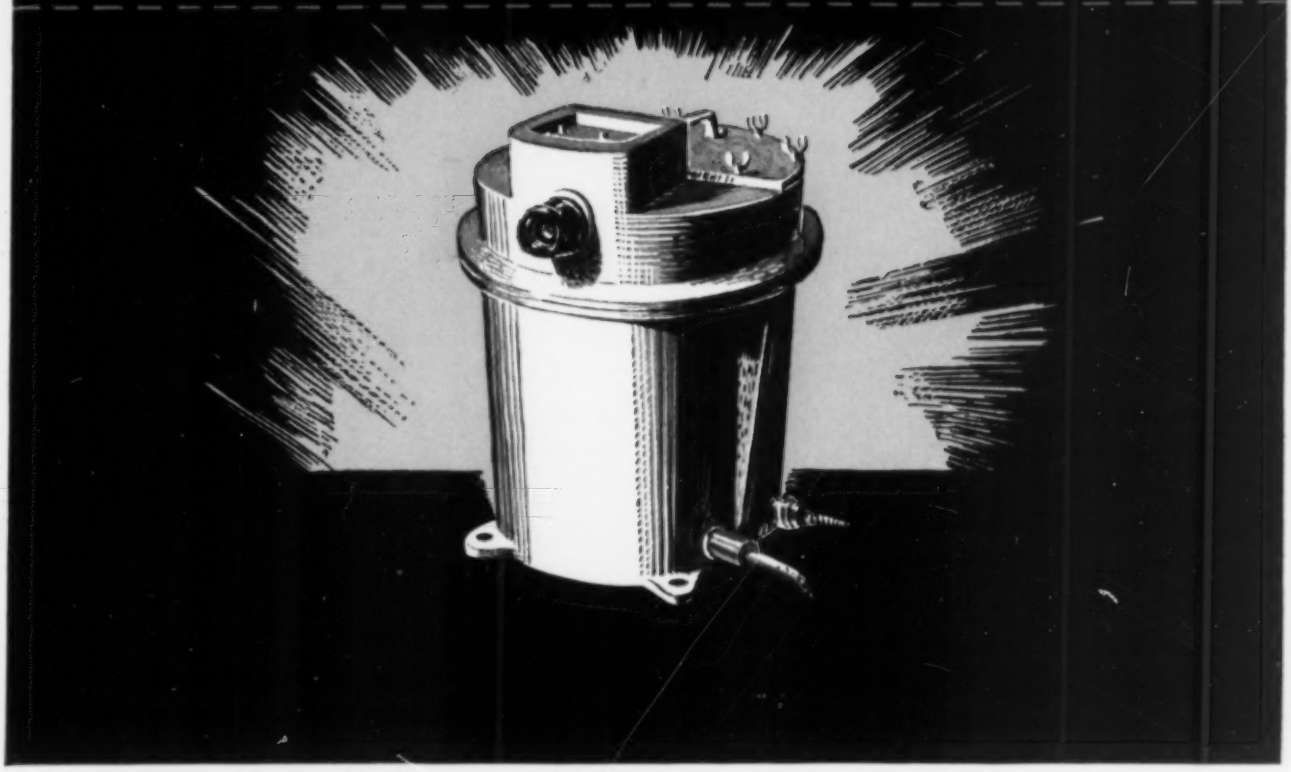
The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio

POWELL VALVES

WORLD'S FASTEST CAMERA
Charts a Burst of Dynamite



TO CAPTURE pictures of explosives *in action,* Hercules scientists designed and built the world's fastest camera. Operating at exposures as fast as *one ten-millionth of a second,* this amazing instrument photographs dynamite at the very instant of its violent chemical change. Even powerful nitroglycerin's path of detonation, traveling at 250 miles a minute, is "stopped" on film by this shutterless, electrically operated camera.

This study of how explosives behave is only a small part of the intensive research being conducted daily by Hercules. Physicists, x-ray workers, microscopists, and other highly trained specialists are constantly searching for new and valuable knowledge on explosives which may prove helpful to you and your business.

HERCULES EXPLOSIVES

HERCULES POWDER COMPANY
INCORPORATED
932 King Street
Wilmington 99 . . . . Delaware

XR-40

On Every Front

GARLOCK Packings, Gaskets and KLOZURE Oil Seals are helping to keep production running at top speed in war plants and essential civilian industries on the home front. Also they are giving dependable service on our many battle fronts—on warships, landing barges, tanks, bombers and fighter planes—for a quicker end to this war of aggression.

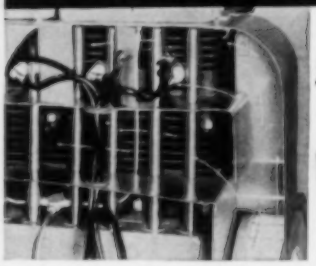
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of of Canada Ltd., Montreal, Que.

THE GARLOCK KLOZURE Oil Seal (Patented) resists oil and water at high or low temperatures. Stays firm; stands up under severe conditions without losing its toughness, density or resiliency.

GARLOCK

AIR in Abundance . .



but it's SCIENTIFICALLY "RATIONED" for WISCONSIN ENGINES

The amount of air required for cooling the lower half of an engine cylinder won't do for the "business end", where the highly compressed fuel charge explodes.

With a continuous, large-volume air-flow to draw from, Wisconsin engineers have long since figured out just how much air to *ration* to each section of the engine, for most efficient cooling.

This is important in relation to the satisfactory performance of your power-operated equipment.

Most H.P. per pound

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

Assure Clean, Dry Air For Pneumatic Tools, Install

INCO
Air-Strainer
WATER TRAPS

With a four-year record of proven success, Inco Air-Strainer Water Traps are helping many users of air-driven equipment cut maintenance costs and lengthen tool life. They improve worker efficiency by keeping clothing dryer. The Inco Trap puts compressed air through three high-velocity collisions with baffle surfaces. Air comes in wet, goes out dry. Easily installed, requires only occasional releasing of trapped water through outlet valve. Each trap has outlets for four pieces of equipment. Installing them throughout your plant saves time and tools. Write for information today or use coupon.

MAIL COUPON TODAY

INCO Engineering Co.
200 Third Street, NE, Cedar Rapids, Ia.

Please send me full information on Inco Air-Strainer Water Traps without obligation.

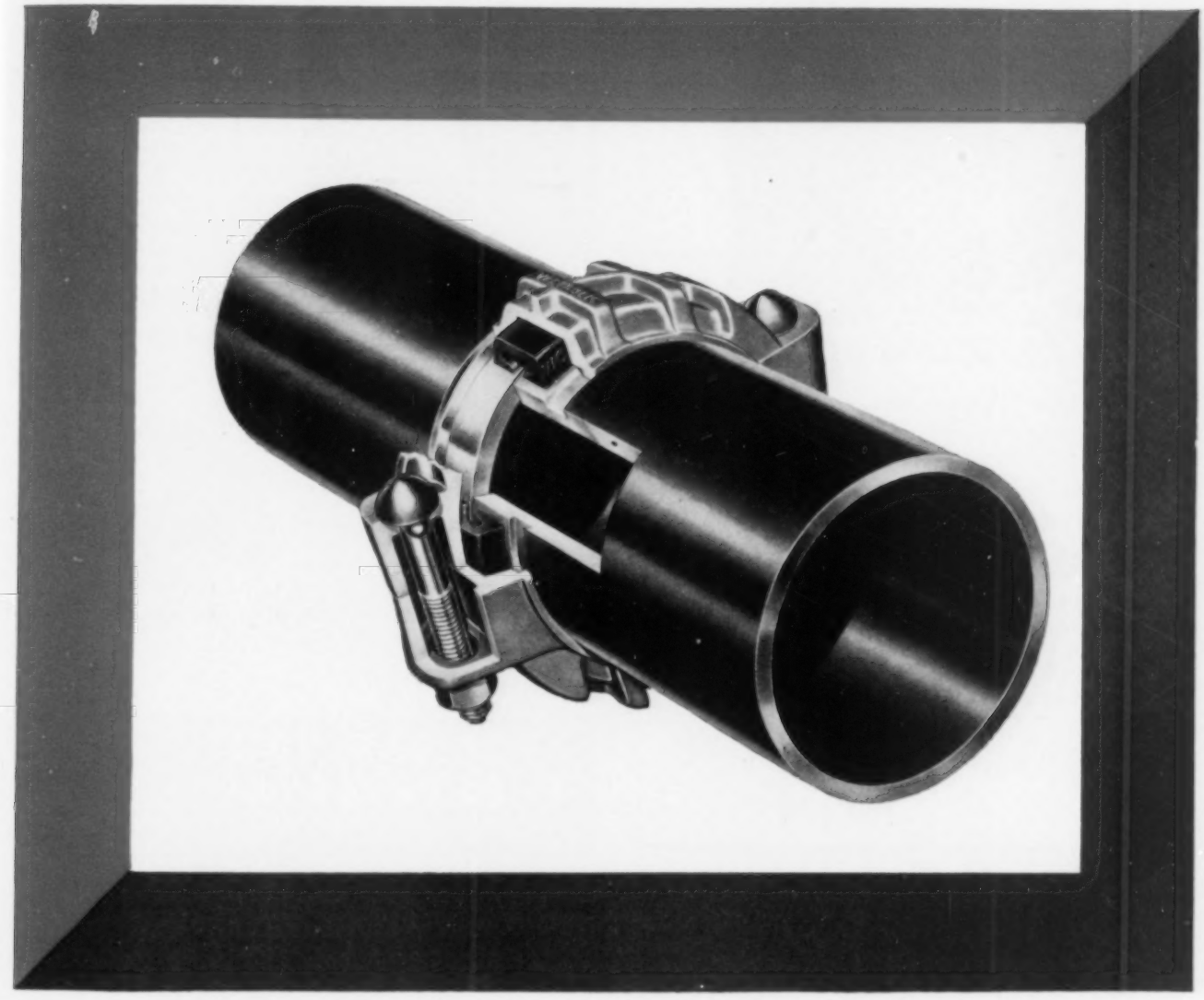
Firm.....

Street.....

City..... State.....

By..... Title.....

.....



This is THE Victaulic Coupling...

WAR BONDS
A PIPE LINE FROM
YOU TO HIM

Here is the simplest... most versatile ALL PURPOSE pipe coupling on the market today... *in fact, of all time.* You can use the genuine Victaulic Coupling on standard steel pipe... wrought iron pipe... cast iron pipe... You can use it instead of threaded, flanged, welded, leaded and other types of pipe joining.

Proof of its versatility? You will find the rugged Victaulic Coupling "*the*" coupling in Oil, Mining, Shipbuilding, Municipal and other industrial fields... not only in the United States but also on all our fighting fronts.

Write for your free copy of the new color-illustrated Victaulic Coupling Catalog and Engineering manual. This catalog gives details of Victaulic pipe couplings, elbows, tees, reducers, caps, laterals, crosses, nipples and accessories for installation and operation of oil, gas, water, air, chemical and other types of pipe lines. Address VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. Other Victaulic offices—Victaulic Inc., 727 West 7th St., Los Angeles 14, California; Victaulic Co. of Canada, Ltd., 200 Bay St., Toronto.

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL FLOW FITTINGS

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OIL MINING MARINE MUNICIPAL INDUSTRIAL

Striking POWER

Striking power, brilliant as the flash of a killing eagle, is built into every air tool by its builder. You can preserve that power indefinitely only by providing Norgren air-borne Lubrication . . . continuously!

NORGREN *air-line* LUBRICATORS

Install directly into air line. Lubricate every working part of the air tool. *Check wear in use. Prevent corrosion when idle.* Automatic. Sight-feed. Size and type for every purpose. Write to C. A. Norgren Co., 220 Santa Fe Drive, Denver, Colorado.

CATALOG 400 *Norgren*

Wherever wire rope is fastened **STANDARDIZE** *on Genuine* **CROSBY CLIPS** *with the Red U-Bolt*

A safe, lasting and easy-to-put-on clip for every size of rope from 1/8-inch to 4-inch.

Sold by leading distributors everywhere

AMERICAN HOIST & DERRICK CO.
SAINT PAUL 1, MINNESOTA
CHICAGO SAN FRANCISCO NEW YORK

THE GENUINE *Crosby Clip* WHEREVER WIRE ROPE IS FASTENED

MAKES *Compressed Air* COME CLEAN

THE JOHNSON GAST *2-way* SEPARATOR

WATER, dirt and oil in compressed air lines can be a big source of trouble and expense—causing imperfect results, and deteriorating air hoses and equipment rapidly.

The Johnson-Gast Separator is the simplest way to make your compressed air come clean. It takes out more than 99% of all troublesome foreign elements, because it employs *both* of the accepted principles of separation—expansion and change of direction. The illustration shows its simple, sturdy construction. It can be used with equal efficiency on steam lines also.

When moisture in the air is vaporized by heat generated during compression, the Johnson-Gast Aftercooler is used to condense all vapor so the Separator can remove it. Where every final trace of oil must be removed—as in paint spraying—the Johnson-Gast Oil Absorber is also used.

1. Air first expands, precipitating most of moisture.
2. "Thousand Baffles," labyrinth of wire mesh, changes flow direction — captures remaining water and dirt.

Write for bulletin showing sizes and capacities of the complete Johnson-Gast line of separating devices.

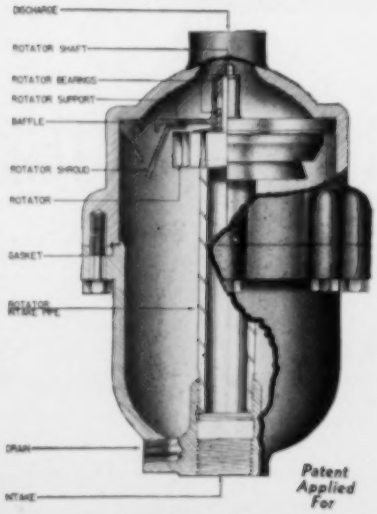
THE JOHNSON CORPORATION
830 Wood Street, Three Rivers, Mich.

JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

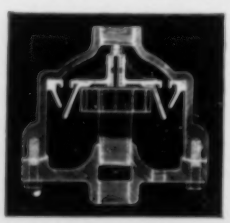
NEW TURBO-ROTOR *Pur-O-fier*

For Compressed Air

This new unit effectively eliminates moisture, oil and scale from compressed air lines. Pur-O-fier utilizes the principle of centrifugal force to separate entrainments from purified air. Once installed it requires absolutely no maintenance. Penstar Tru-Bond oiless bearing guarantees long, trouble-free operation. Manual or automatic drains provided.



Patent Applied For



Drawing shows turbo-rotor, shroud and baffles. The design of the baffles precludes the possibility of capillary action of entrainments resulting from high velocity.

THREE MODELS AVAILABLE—A-1 will accommodate volumes from 1/2 to 5 cu. ft. A-2, volumes from 10 to 35 cu. ft. A-4, volumes from 35 to 100 cu. ft. Multiple units are recommended for volumes above this range. Pur-O-fier is the only standard unit that can be engineered to meet any air volume for regular or intermittent service.

BIRD-WHITE COMPANY
3120 West Lake Street, Chicago, Illinois

AIR POWER

One of the first instances of *air power* aiding manpower was undoubtedly the pressure of air upon the sail of a primitive canoe.

Centuries later, but still over two thousand years ago, air-minded men compressed the air in vessels made of animal skins. This first man-made air power was used for operating temple doors, giving voice to stone gods, or for primitive smelting.

Today, hundreds of vital processes depend upon mechanically *compressed air* at pressures from a few ounces to thousands of pounds per square inch. Countless mechanical operations are performed in industries with the help of compressed air and air-operated machinery.

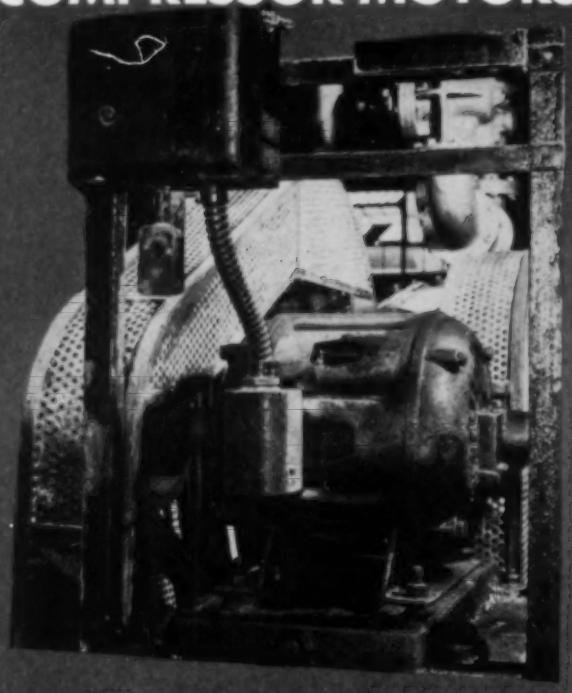
To the Air-Minded Men of Today, who are using Air Power—to increase production, cut manufacturing costs or improve their product—we offer practical assistance based on over seventy years experience in design, construction and application of compressed-air equipment.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

6-492

Wagner
COMPRESSOR MOTORS



For continuous and efficient, dependable service!

THE precision-building skill and experience gained by Wagner in more than half a century of producing dependable motors is reflected in the reliable performance of thousands of compressors motorized with Wagner motors.

Wagner compressor motors embody the very latest improvements in motor design which contribute toward such essentials as simplicity, ruggedness, and dependability.

If you need motors to drive compressors used in producing war equipment–specify Wagner compressor motors.

MOTORS
TRANSFORMERS
UNIT SUBSTATIONS
INDUSTRIAL BRAKES
BRAKE LINING

M44-4

Write FOR BULLETINS

Bulletins MU-182 and MU-183 describe and illustrate the complete line of Wagner motors—a motor for every purpose.

Wagner Electric Corporation
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

Illustration:

This tank track part is fabricated by brazing together precision machined alloy tubing and forgings.

Hydrogen Copper Brazed, cooled, re-heated and quenched by Burgess-Norton in one continuous furnace operation.

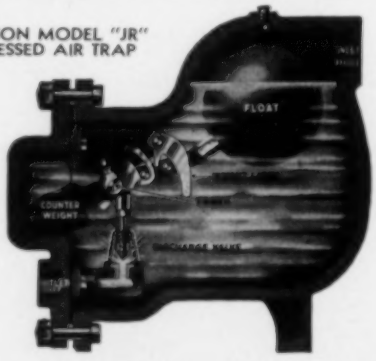
of the completeness of Burgess-Norton's facilities for post-war production of precision parts which will be available to manufacturers when Victory Day draws nearer.

Burgess Norton
MANUFACTURING COMPANY
40 years in GENEVA, ILLINOIS

Precision Finishing as performed by Burgess-Norton is exemplified by the production of piston pins with finishes as fine as 2 micro inches.

A Part is Never Made Right unless it is Satisfactory to Our Customers

NICHOLSON MODEL "JR"
COMPRESSED AIR TRAP



Picture of

TROUBLE-SHOOTER No. 1 FOR AIR SYSTEMS

Nicholson Model "JR" Compressed Air Traps are hanging up records for keeping air tanks, receivers, aftercoolers, etc., free from trouble-making collections of water and oil. Pressures to 200 lbs.

BULLETIN 341

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

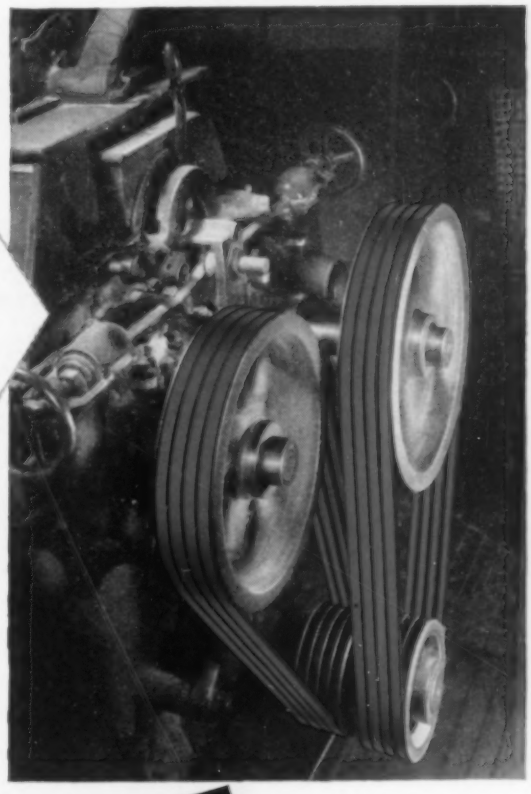
TOUGH DRIVE PROBLEMS SOLVED BY DAYTON V-BELT DISTRIBUTORS

A Flour Mill had this Problem!

A second-break roll was driven by ordinary belts with pulleys arranged so that the drive was geared down to provide two different speeds for two different rolls. The ordinary belts slipped badly and where two ran parallel on unit shaft pulleys to provide the speed reduction, the belts tended to go together. Faced with this situation, the plant phoned the Dayton V-Belt Distributor.

Here's How it was Solved!

The distributor's factory-trained Dayton V-Belt expert engineered the conversion to V-belts as shown in the accompanying photograph. The Dayton V-Belts do not slip...They make possible a differential in speed, and the drive is now operating 24 hours a day with such complete satisfaction that the company is changing over all mills to Dayton V-Belt Drives.



Take Advantage of this Valuable Free Service by Factory Trained Experts

Service like that described above is available to you. Simply call in your factory-trained Dayton V-Belt Distributor. He can expertly engineer conversion from troublesome, power-wasting drives to smooth-running, hard-gripping, long-lasting Dayton V-Belts—anything from fractional to a thousand horsepower.

Dayton Rubber has had more than 30 years' experience in building V-belts of natural and synthetic rubber and is today the world's largest manufacturer of V-belts. You can rely on Dayton V-Belts for the utmost in performance—and on Dayton V-Belt Distributors for the utmost in prompt, expert service.

CALL YOUR DAYTON V-BELT DISTRIBUTOR OR WRITE DIRECT

THE DAYTON RUBBER MFG. CO., DAYTON 1, OHIO

The World's Largest Manufacturer of V-Belts

Dayton Rubber Export Corp., 38 Pearl St., New York, N.Y., U.S.A.

Cable Address: WIDBLOCO

MAINTAIN VICTORY SPEEDS—CONSERVE YOUR TIRES

V-Belts by

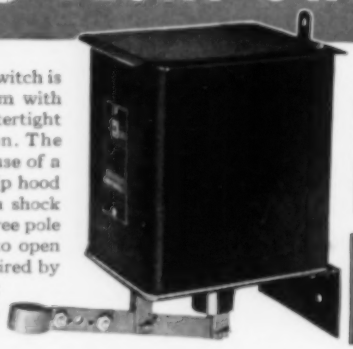
Dayton Rubber

REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark of Technical Excellence in Synthetic Rubber

Marine FLOAT SWITCH

DRIPPROOF AND WATERTIGHT
HIGH SHOCK CONTACT BLOCK
TWO OR THREE POLE
CLASS 9036 • TYPE AW-H



● The class 9036 type AW-H float switch is built for Marine Service to conform with requirements for a dripproof and watertight device of shockproof construction. The switch differs from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block of two or three pole form. The switch can be arranged to open or close on rise in liquid level as required by application. Mounting is three point by means of bracket flange and foot, as illustrated. **Write for Bulletin 563.**

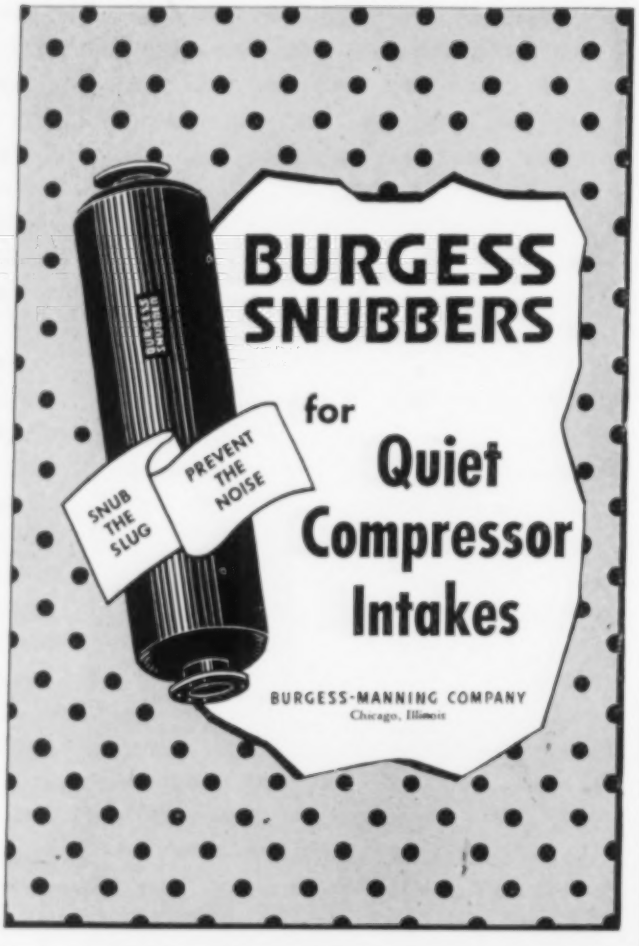
ELECTRICAL RATINGS

Voltage	Single Phase A. C.	Polyphase A. C.	D.C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	.....
32V.	.....	.....	½ H.P.

REGULATOR DIVISION

SQUARE D COMPANY

DETROIT • MICHIGAN



BURGESS SNUBBERS

for

Quiet Compressor Intakes

BURGESS-MANNING COMPANY
Chicago, Illinois

There Is No Compressed Air Condition So Bad In Any Factory That We Cannot Correct and Completely Remedy

WATER removed from AIRLINES AUTOMATICALLY with the MURPHY SEPARATOR

SIZES ½" TO 4" PIPE

Literature and Prices on request

RESULTS - - - GUARANTEED
NO ABSORBENTS - NO CHEMICALS
AFTERCOOLERS - - - SPRAYERS

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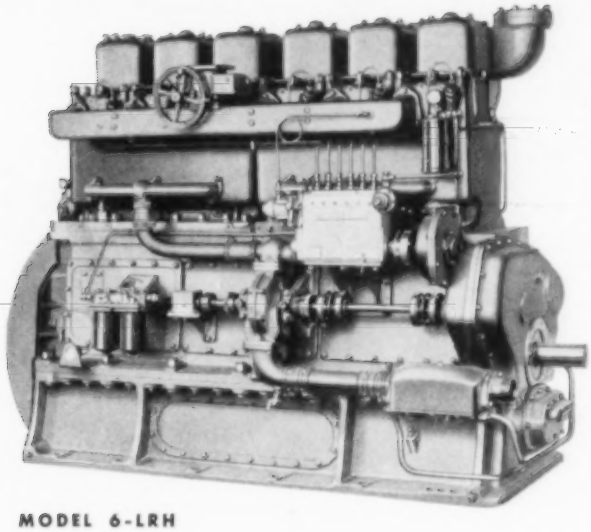
ATLAS STEEL CASTING COMPANY

OPEN HEARTH & ELECTRIC STEEL

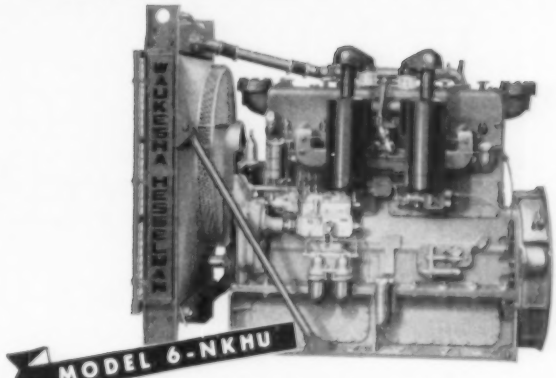
1963 ELMWOOD AVENUE

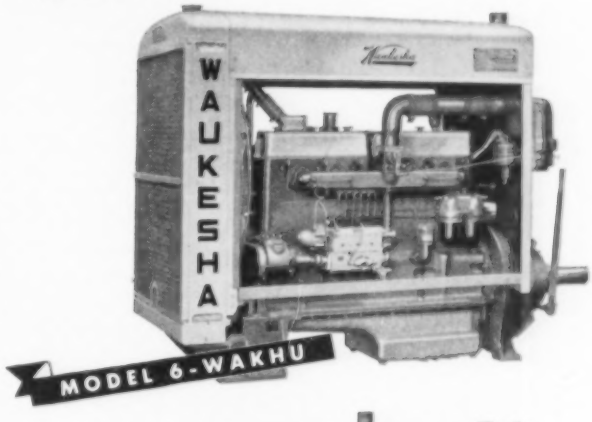
BUFFALO, N. Y.

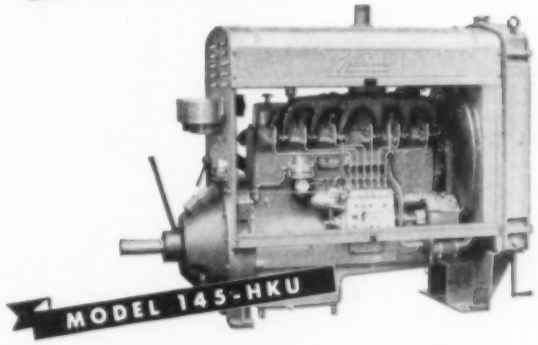
WAUKESHA
HESSELMAN *Oil* ENGINES

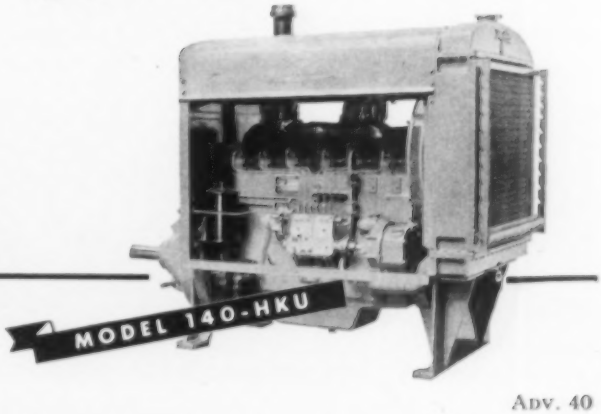


MODEL 6-LRH









In wartime every Waukesha Engine is a war-work engine. All Waukesha production is for the use of the armed forces. Until the war is won, Waukesha postwar engine designs are not being shown.

But peacetime models are on the way. New advantages and greater user conveniences will make the new peacetime Waukesha-Hesselman *the world's most wanted diesel-oil engine.*

After the war the fuel problem for engine-driven equipment will be serious *unless it is Hesselman powered.* Because it burns those widely sold Nos. 1, 2 or 3 domestic furnace oils as well as high-speed diesel fuels . . . either high or low cetane. . . Hesselman will be the contractor's first choice for country-wide use. And a Hesselman may be converted from fuel injection to carbureted gas or gasoline without changing a single major part. *No compression ignition Diesel can be converted from fuel oil to gas or gasoline so quickly, or easily.* Even gasoline injection is possible with the Hesselman.

And Hesselman's *electric and positively timed ignition* and lower pressures give easier starting, less shock load, longer life, lower upkeep than with any other diesel-oil engine.

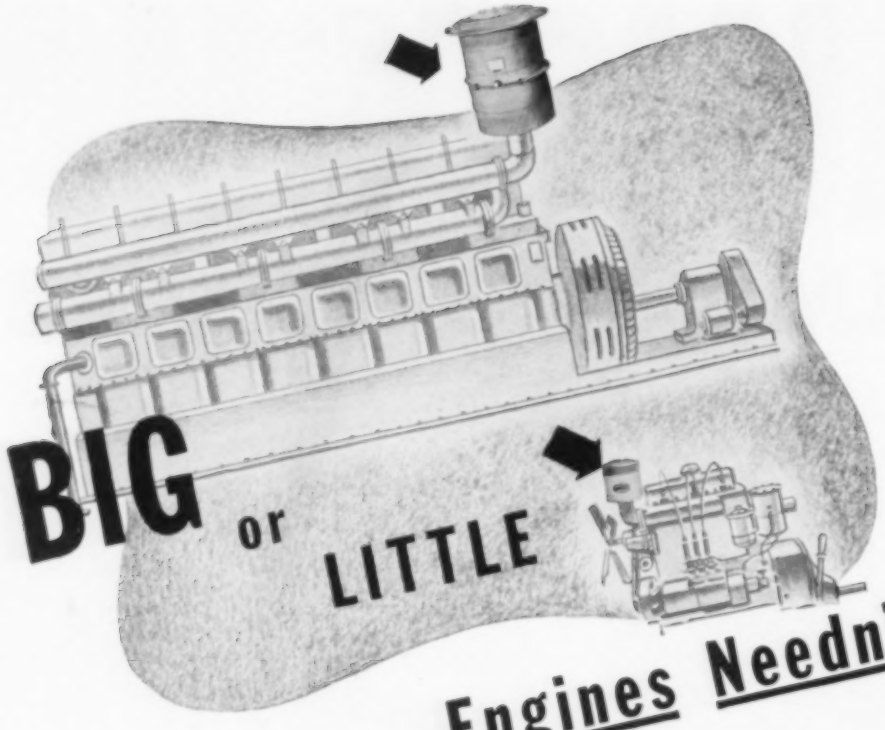
For your future engine needs, consult Waukesha now. Get Bulletin 1079

Engine Model	No. of Cyls.	Bore and Stroke, In.	Displ. Cu. In.	Speed RPM
*130-HS	4	3¾ x 5	221	1000-1800
*130-HL	4	4 x 5	251	1000-1800
*VRZH	4	4⅝ x 5¼	353	1000-1600
*140-HS	6	4¼ x 5½	468	1000-2250
*140-HK	6	4½ x 5½	525	1000-2250
*145-HK	6	5¼ x 6	779	1000-2000
6-WAKH	6	6¼ x 6½	1197	800-1600
6-NKH	6	7 x 8½	1962	600-1050
6-LRH	6	8½ x 8½	2894	600-1050

*These Hesselman Engines are true *multi-fuel engines*, and can be converted to burn natural gas or gasoline, with no internal changes. The others can also be converted to carburetor engines with a minimum of effort.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK • TULSA • LOS ANGELES



BIG or LITTLE Engines Needn't "SNORE"

A Type for Every Application

Oil bath type filter-silencer for heavy-duty service. Filter element features automatic oil-washing action. Silencing chamber requires no attention.

Closed circuit (in-line) Multimaze filter-silencer. Design permits both air intake and unit to be placed in best locations.

Unimaze filter-silencer for use with small engines and compressors where dirt conditions are not severe.

Engine and compressor intake air can be a nuisance as well as a danger. It requires filtering to remove harmful abrasives. And in many installations, effective silencing vastly improves working conditions and operators' efficiency.

Air-Maze filter-silencers combine various types of filters with efficient silencing chambers. These sound dampeners are integral parts of the unit. Sizing the filter, therefore, automatically provides the correct silencing chamber.

Air-Maze engineers will gladly recommend the correct type for your engine and compressor. For data on these and other Air-Maze products, write for General Catalog AGC-144 and Bulletin FSP-89 on filter-silencers.

AIR-MAZE CORPORATION • *Engineers and Manufacturers* • **CLEVELAND 5, OHIO**

Representatives in Principal Cities • *In Canada:* Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor; Fleck Bros., Ltd., Vancouver, B. C.

ARMY E NAVY

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

WHEN YOU NEED

Motor Control Accessories

consult Westinghouse Buying Data

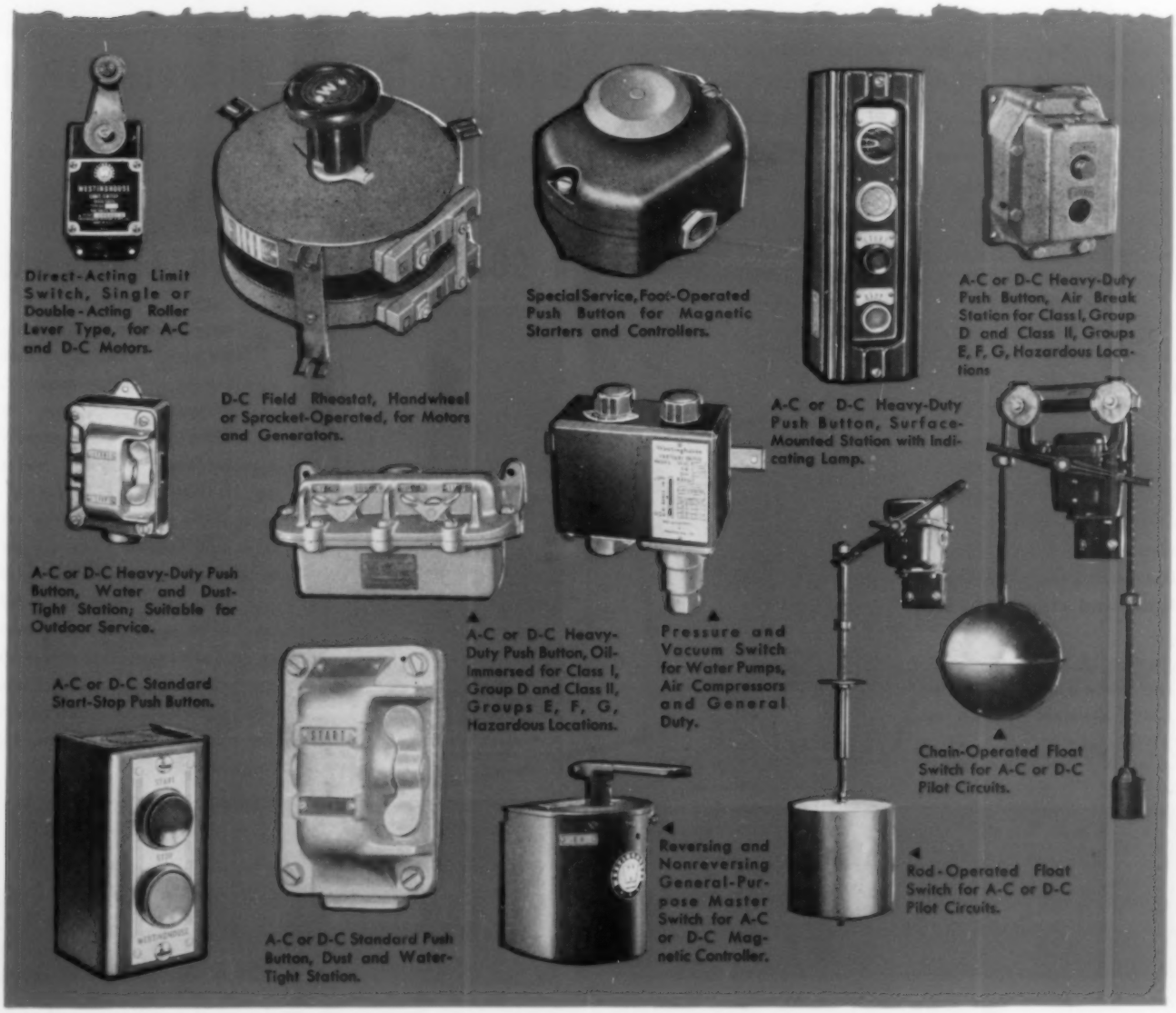
(NEW CATALOG 7000)

With the new Westinghouse Buying Data, you can select and purchase the proper motor control in half the time.

Data, as presented, is striking in its newness. It's easier to read, easier to understand, and easier to use than any published previously by any manufacturer.

Chances are—if you are a buyer of motors and controls—that you have already received a copy of this new Catalog 7000 by mail. However, if you have not received your copy, write, wire or phone your nearest Westinghouse district office. (Requests will be filled through district offices only — no mailing from Westinghouse headquarters at East Pittsburgh.) J-60551

Westinghouse PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE *Control Accessories*


Direct-Acting Limit Switch, Single or Double-Acting Roller Lever Type, for A-C and D-C Motors.
D-C Field Rheostat, Handwheel or Sprocket-Operated, for Motors and Generators.
Special Service, Foot-Operated Push Button for Magnetic Starters and Controllers.
A-C or D-C Heavy-Duty Push Button, Air Break Station for Class I, Group D and Class II, Groups E, F, G, Hazardous Locations
A-C or D-C Heavy-Duty Push Button, Surface-Mounted Station with Indicating Lamp.
A-C or D-C Heavy-Duty Push Button, Water and Dust-Tight Station; Suitable for Outdoor Service.
A-C or D-C Heavy-Duty Push Button, Oil-Immersed for Class I, Group D and Class II, Groups E, F, G, Hazardous Locations.
Pressure and Vacuum Switch for Water Pumps, Air Compressors and General Duty.
A-C or D-C Standard Start-Stop Push Button.
Chain-Operated Float Switch for A-C or D-C Pilot Circuits.
Reversing and Nonreversing General-Purpose Master Switch for A-C or D-C Magnetic Controller.
Rod-Operated Float Switch for A-C or D-C Pilot Circuits.
A-C or D-C Standard Push Button, Dust and Water-Tight Station.

W·A·B *Pneumatic* Control Systems

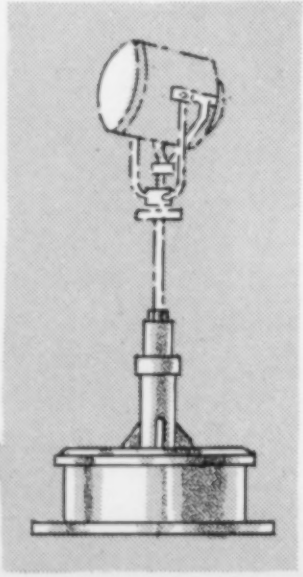
Remote Control *for* Searchlights

Duo-Flo Valve

Typical of the new applications for pneumatic controls is the Remote Control System for Searchlights as used on river vessels. Location of the control station remote from the pilot house gives the operator full visibility of the beam. Training is by handle manipulation of a Duo-Flo Valve to drive motors in the searchlight base.

The single handle controls speed and simultaneous training for transverse and elevation. Fast and precisely coordinated training is obtained merely by wrist flex.

This system is adaptable to many purposes involving coordinated control of multiple motions. Lateral and vertical motions can be controlled singly or together at variable speeds, with arrestment or quick reversal of either while continuing the other—all from one small handle.

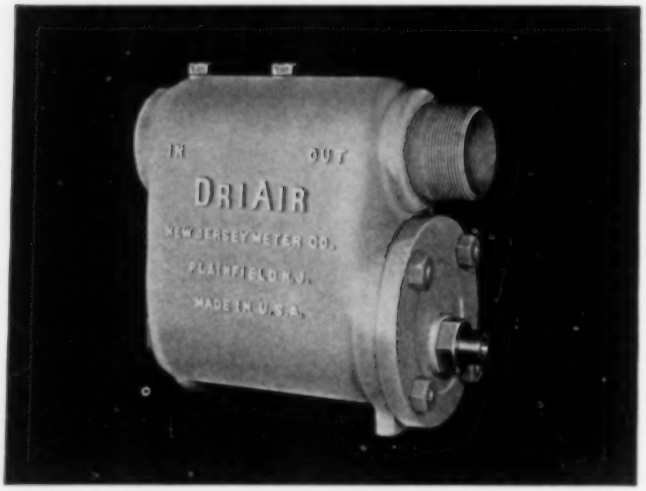


Let us engineer a Pneumatic Control System to YOUR job.

Westinghouse Air Brake Co.

Industrial Division - - - Wilmerding, Pa.

DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

● The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

The Bucyrus-Erie DOZERSHOVEL

GETS IN . . . AND DIGS!

There's plenty of room all around as this Dozershovel moves into the low, narrow archway to pick up a big load of bricks . . .

. . . It carries the load to the spoil pile, dumps, then returns to repeat the operation — in a profitable hurry.

Low clearance . . . close quarters . . . tough digging . . . The job of cleaning out an open hearth furnace was painfully slow and expensive, for it had to be done by hand — until a Bucyrus-Erie Dozershovel went to work on it. Then things were different, because the Dozershovel's low overall height allowed it to move right in under the arch, its powerful digging action let it take big bucket loads, its maneuverability permitted easy going from furnace to spoil pile. This important war job could now be done fast, economically, profitably.

This is just one of the many unusual jobs, hitherto done by hand, that the versatile Dozershovel handles efficiently. In addition to the unit's use as a shovel, a quickly interchangeable dozer blade permits full-fledged dozer service, and a hook on bucket or blade provides for utility crane application. Get the complete story of this new unit for T9 and TD9 International TracTracTors from your International distributor.

M-65

BACK THE ATTACK!

BUY WAR BONDS

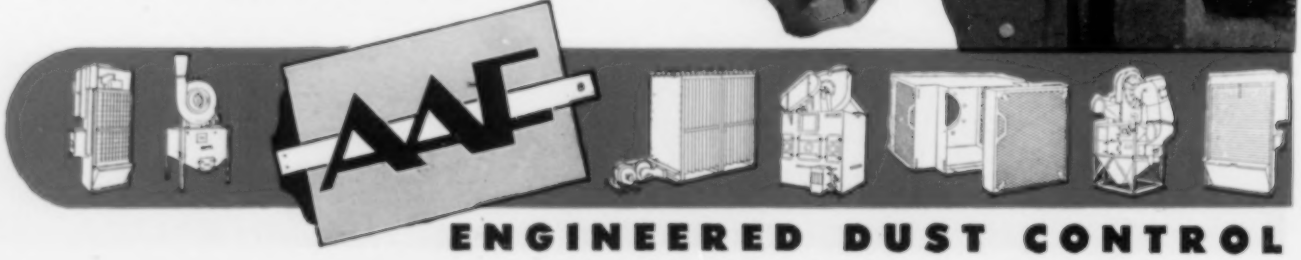
BUCYRUS ERIE TRACTOR EQUIPMENT

SEE YOUR
INTERNATIONAL TRACTRACTOR
DISTRIBUTOR

Your FREE copy will come by return mail!

Engines and compressors deserve the protection afforded by efficient air cleaners. The Cycoil oil bath cleaner was developed for use under the most severe dust conditions and no other air cleaner even approaches its efficiency in removing the finer dusts which do the real damage. Send for Bulletin No. 130 D, illustrated here, for complete engineering and installation data.

AMERICAN AIR FILTER CO., Inc.
402 Central Avenue, Louisville 8, Kentucky
In Canada: Darling Bros., Ltd., Montreal, P. Q.



ENGINEERED DUST CONTROL

MOVE ORE

the Easy Way

The illustrations show a Size 15NN-1G Tugger Hoist working with a 36" quarter box type scraper in zinc lead ore. The distance traveled is about 150 feet.

● Modern methods in development and production call for many applications of slusher hoist and scraper units. These smooth-working combinations are the choice where material has to be moved quickly and at a low cost.

I-R Slusher Hoists Have Many Advantages:

Either air or electric drive.
Many sizes and types with capacities from 1,100 to 10,000 pounds with speeds varying from 125 to 450 feet per minute.
Sturdy construction for heavy work.
A design that assures low maintenance costs.

With I-R Slusher Hoists:

You can handle large tonnages.
Distances between raises can be increased.
Less timbering is required.
The area can be worked much faster.
Multi-direction mucking is possible with a turntable mounting.
Scraper operators can be less experienced men.
Hoist can be moved from job to job.

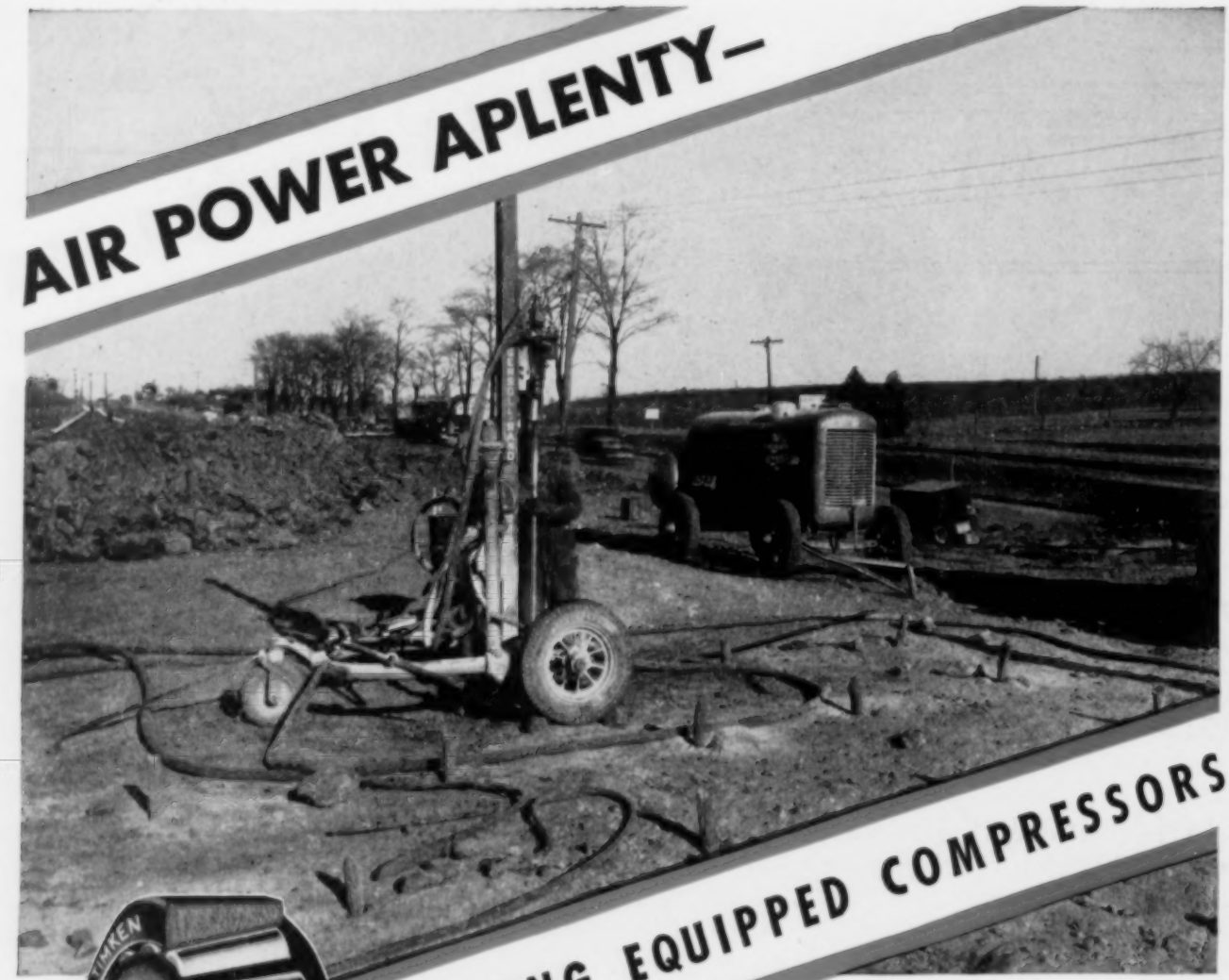
We have a size and type for every kind of mucking. Consult our nearest engineering service division for more detailed information.

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

16-489

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

AIR POWER APLENTY—



WITH TIMKEN BEARING EQUIPPED COMPRESSORS

A typical example of modern efficiency in the production and application of compressed air is shown in this photograph, taken on a road building job.

Ingersoll-Rand 315-CFN Portable Compressors are seen supplying power to Ingersoll-Rand Model FM-2 wagon drills. Hidden from view, but none the less important to the performance and endurance of this equipment are Timken Tapered Roller Bearings — put there by the foresight of the manufacturer to prevent friction and wear; to afford full protection against radial, thrust and combined loads; and to hold moving parts in correct and constant alignment. They are used on the crank shaft and in the road wheels of the compressors and in the worm gear drives and wheels of the wagon drills.

Ingersoll-Rand has proved, by years of experience with them, that Timken Bearings can be depended upon to provide anti-friction efficiency in full — and so have users of Ingersoll-Rand compressors. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS